MEASI
Institute *of* Management

FINANCIAL MODELLING (534E7B) – COURSE MATERIAL

VISION & MISSION STATEMENTS

Vision

To be an oasis of knowledge to the seeker, to nurture one's creativity and research acumen, and to instil a unique blend of leadership, innovative spirit and empathy in response to the ever-evolving business ecosystem.

Mission

- Provide a pedagogy that blends academic rigor and experiential learning.
- Inculcate an entrepreneurial mindset through curated activities
- Establish a conducive environment for research.
- Foster a culture of innovation and collaboration to progress in a dynamic business landscape.
- Promote humanistic values to produce socially responsible leaders.

Program Educational Objectives (PEOs)

PEO 1 – Employability: To develop students with industry specific knowledge & skills to meet the industry requirements and also join public sector undertaking through competitive examinations.

PEO 2 - Entrepreneur: To create effective business service owners, with a growth mindset by enhancing their critical thinking, problem solving and decision-making skills.

PEO3 – Research and Development: To instil and grow a mindset that focusses

efforts towards inculcating and encouraging the students in the field research and development.

PEO 4 – Contribution to Business World: To produce ethical and innovative business professionals to enhance growth of the business world.

PEO 5 – Contribution to the Society: To work and contribute towards holistic development of society by producing competent MBA professionals.

Program Outcome

PO1 - Problem Solving Skill; Apply knowledge of management theories and practices
to solve business problems.

PO2 - Decision Making Skill; Foster analytical and critical thinking abilities for data-
based decision making.

PO3 - Ethical Value; Ability to develop value based leadership ability.

PO4 - Communication Skill; Ability to understand, analyze and communicate global, economic, legal and ethical aspects of business.

PO5 - Individual and Leadership Skill; Ability to lead themselves and others in the achievement of organizational goals, contributing effectively to a team environment.

PO6 - Employability Skill; Foster and enhance employability skills through subject knowledge.

PO7 - Entrepreneurial Skill; Equipped with skills and competencies to become an entrepreneur.

PO8 - Contribution to community; Succeed in career endeavors and contribute

significantly to the community.

Program Specific Objectives

PSO 1: Finance: The students should demonstrate proficiency in analyzing financial statements, evaluating investment opportunities and making financial decision to maximize shareholders' value.

PSO 2: Marketing: Students should be able to create a comprehensive marketing plan that

integrates effective communication strategies, leading to customer success and the accomplishment of marketing objectives.

PSO 3: Logistics: Students will acquire knowledge of inventory management for domestic and global supply chains, thereby developing problem-solving skills in logistics to optimize supply chain efficiency.

PSO 4: Business Analytics: The students should able to analyze data, communicate insights, take data-driven decisions and solve business problems effectively.

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FINANCIAL MODELLING SYLLABUS

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Financial Modelling	Elective	2	-	1	-	3	3	25	75	100

Course Objectives	
C1	To equip the students with the knowledge of different aspects of financial modelling and be familiar with using financial functions in a spreadsheet.
C2	To gain an understanding of the valuation tools and techniques used in bond and equity valuation.
C3	To design and construct useful and robust corporate modelling applications
C4	To learn about the risk and return of a portfolio and how to measure them using different methods.
C5	To acquaint the students with the fundamentals of derivative modelling and their application

SYLLABUS

UNIT	Details	No. of Hours	Course Objectives
I	**Introduction to financial modelling & built-in functions using spread sheets**-Introduction to Financial Modelling- Need for Financial Modelling- Steps for effective financial modelling - Introduction to Time value of money & Lookup	9	C1

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	array functions: FV, PV, PMT, RATE, NPER, Vlookup, Hlookup, if, countif, etc - Time value of Money Models: EMI with Single & Two Interest rates – Loan amortization modelling-Debenture redemption modeling.		
II	**Bond & Equity Share Valuation Modelling-**Bond valuation – Yield to Maturity (YTM): Rate method Vs IRR method-Flexi Bond and Strip Bond YTM Modelling-Bond redemption modelling – Equity share valuation: Multiple growth rate valuation modelling with and without growth rates.	9	C2
III	**Corporate Financial Modelling-**Altman z score, bankruptcy modelling - indifference point modelling – financial break-even modelling - corporate valuation modelling (two stage growth) - business modelling for capital budgeting evaluation: payback period, npv, irr and ARR.	9	C3
IV	**Portfolio Modelling-**Risk beta and annualized return – security market line modelling – portfolio risk calculation (equal proportions) - portfolio risk optimization (varying proportions) - portfolio construction modeling.	9	C4
V	**Derivative Modelling-** option pay off modelling: long and short call & put options -option pricing modeling (b-s model) - optimal hedge contract modelling	9	C5
	Total	**45**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	**Program Outcomes**
CO1	Identify the relevance of financial models for various corporate finance purposes.	PO1,PO2,PO6,PO7
CO2	Estimate the securities by using the modelling techniques	PO1,PO2, PO6

CO3	Calculate efficient financial budgeting and appraise the equity value of a company by applying various methods.	PO1,P2,PO6,PO7
CO4	Assess the evaluation of securities through the tools and techniques of portfolio models	PO1,PO2
CO5	Appraise the aptitude of analyzing the investment decision-based on derivatives.	PO1,PO2

CO-PO MAPPING

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	3	3				2	2	
CO 2	3	3				2		
CO 3	3	3				2	2	
CO 4	3	3						
CO 5	3	3						

3-Strong 2-Medium 1-Low

FINANCIAL MODELLING (534E7B) – COURSE MATERIAL

UNIT 1

1.1. What is Financial Modelling?

Definition:

- Financial Modelling is the process of creating a spreadsheet-based representation of a real-world financial scenario to forecast future financial performance or analyze potential investments
- Financial Modelling is the process of creating a quantitative representation of a real-world financial situation using tools such as Excel to forecast a company's performance or evaluate financial decisions.

Meaning of Financial Modelling:

Financial Modelling is the process of building a mathematical or computational model in a spreadsheet to represent the financial performance of a business, project, or investment. It involves using historical data, assumptions, and formulas to forecast future outcomes such as revenue, costs, profits, cash flows, and valuations.

A financial model typically includes key financial statements like the Income Statement, Balance Sheet, and Cash Flow Statement. It is used to simulate real-life financial situations and support strategic decision-making.

In simple terms:
It is the art of building a spreadsheet that helps businesses make informed decisions based on future projections, valuations, and investment analysis.

1.2. NEED FOR FINANCIAL MODELLING:

Financial modeling is a crucial tool for businesses, investors, and financial analysts. Here are some of the key needs and benefits of financial modeling:

1. Forecasting and Planning: Financial models help predict future financial outcomes, enabling informed decision-making and strategic planning.

2. Risk Management: Models identify potential risks and opportunities, allowing for proactive mitigation and optimization.

3. Investment Evaluation: Financial models assess investment opportunities, determining their viability and potential returns.

4. Funding and Capital Raising: Accurate models help secure funding by demonstrating a company's financial potential to investors.

5. Performance Monitoring: Models track actual performance against projections, facilitating adjustments and improvements.

6. Scenario Analysis: Financial models enable exploration of different scenarios, such as market changes or economic fluctuations.

7. Mergers and Acquisitions: Models evaluate potential acquisitions or partnerships, determining their financial impact.

8. Budgeting and Resource Allocation: Financial models optimize resource allocation, ensuring efficient use of funds.

9. Stress Testing: Models simulate challenging scenarios, ensuring business resilience and preparedness.

10. Communication: Financial models facilitate communication among stakeholders, providing a shared understanding of financials.

1.3. Objectives of Financial Modelling / Why is Financial Modelling Important?

- To assess feasibility of projects or businesses
- To value a business or asset
- To forecast future performance
- For capital budgeting and decision-making
- For raising capital from investors or banks
- For merger and acquisition decisions
- For risk analysis and contingency planning

1.4. Purpose of Financial Modelling

Financial Modelling serves several critical purposes:

Purpose	Description
Business Planning	Estimate future performance, set goals, and a strategy with financial objectives.
Decision Making	Evaluate different business scenarios to choose best course of action.
Investment Appraisal	Assess financial viability of projects using metrics NPV, IRR, Payback Period.
Valuation	Determine the worth of a business for fundrai acquisition, or IPO.
Loan Assessment	Demonstrate repayment ability and calculate EMIs loan schedules.
Performance Monitoring	Compare actual vs. forecasted data and monitor performance indicators (KPIs).
Fundraising	Support investor pitches and bank loan applicat with data-driven projections.
Scenario & Sensitivity Analysis	Understand risks and impacts of changes in assumptions like costs, demand, or pricing.

1.5. Applications of Financial Modelling

S.No	Application Area	Purpose
1.	Investment Analysis	To evaluate whether an investment is profitable.
2.	Business Valuation	To estimate the value of a company using DCF or comparable analysis.
3.	Budgeting & Forecasting	To project future revenues, expenses, and profits.

S.No	Application Area	Purpose
4.	Loan Amortization & EMI Planning	To determine EMI amounts and repayment schedules.
5.	Mergers & Acquisitions	To analyze the financial impact of merging or acquiring companies.
6.	Risk Analysis (What-If / Scenario)	To test how business reacts to changes in interest rates, demand, etc.
7.	Capital Budgeting	To evaluate the viability of long-term projects using NPV, IRR, etc.
8.	Portfolio Management	To track and optimize a portfolio of financial assets.
9.	Start-up Planning	To project cash flows, breakeven, and funding needs for new businesses.
10.	Financial Statement Analysis	To build integrated models (P&L, Balance Sheet, Cash Flow).
11	Investment Banking	M&A deal modelling, synergy analysis
12	Corporate Finance	Valuation of firms, IPO pricing, raising capital
13	Project Finance	Forecasting cash flows of infrastructure projects
12	Startups	Revenue and cost forecasting, investor pitching
15	Credit Analysis	Loan repayment modelling, debt coverage ratios
16	Equity Research	Earnings forecasts, share price valuation

1.6. Common Tools Used for Modelling

Tool	Application	Example Use-Case
Microsoft Excel	Core financial modelling, forecasting, ratio analysis, and what-if scenarios	- Build EMI schedules, loan amortization, NPV/IRR calculations, budget forecasts
		- Create integrated models: P&L, Balance Sheet, Cash Flow

Tool	Application	Example Use-Case
		- Valuation models (Discounted Cash Flow, Comparable Analysis)
Google Sheets	Collaborative modelling, real-time updates, academic project sharing	- Team-based forecasting or startup financial plan for class assignments
		- Shared budget model or capex planning among project team members
		- Real-time group model presentations or revisions
Python	Advanced analytics, automation, financial simulations, algorithmic modelling	- Automate portfolio risk analysis or backtesting investment strategies
		- Build Monte Carlo simulation for project valuation
		- Fetch and analyze real-time stock data using APIs
Power BI	Interactive dashboards, financial reporting, scenario visualization	- Create financial dashboards with Excel model integration (e.g., sales trends, KPIs)
		- Visualize department-wise expenses, forecasts, breakeven points
Tableau	Advanced data visualization and presentation of model outcomes	- Visual storytelling of a startup's 5-year financial projection
		- Dynamic charts for semester project submissions or business plans

1.7. Overview of Excel in Financial Modelling

Excel is the most widely used tool for building financial models due to its versatility, formula power, and ability to structure, link, and analyze complex datasets. A well-built Excel model provides transparency, scalability, and automation in financial calculations.

Key Excel Features Used:

Function Type	Examples
Financial	FV, PV, PMT, NPER, RATE
Logical	IF, AND, OR, IFERROR
Lookup	VLOOKUP, HLOOKUP, INDEX, MATCH, XLOOKUP
Statistical	AVERAGE, STDEV, COUNTIF, SUMIF
Data Tools	Data Tables, Goal Seek, Scenario Manager
Charts & Graphs	Line Chart, Column Chart, Pie Chart for visual insights

Excel Usage in Modelling:

- Building **assumption sheets** (growth rate, costs, tax rate, etc.)
- Linking sheets using formulas for **dynamic updates**
- Creating **profit & loss**, **balance sheet**, and **cash flow statements**
- Performing **scenario and sensitivity analysis**
- Designing **dashboards** for reporting

1.8. ESSENTIAL REQUIREMENTS FOR FINANCIAL MODELLING

a. Technical Requirements:

- Proficiency in Excel (formulas, functions, formatting)
- Understanding of financial statements

- Logical structuring of sheets
- Familiarity with Excel tools: Data validation, conditional formatting, Pivot Tables, Charts

b. Conceptual Requirements:

- Clear financial objectives
- Understanding of finance principles: Time Value of Money, Capital Budgeting, Working Capital, ROI
- Clarity in assumptions and projections
- Analytical thinking and financial acumen

c. Best Practices:

- Separate sheets for input, calculations, and output
- Use consistent formatting and color codes
- Include error-checking formulas
- Document assumptions clearly

1.9. STEPS FOR EFFECTIVE FINANCIAL MODELLING

1. **Define the Purpose**: Clearly determine the model's objective, such as forecasting, investment evaluation, or scenario planning.

2. **Gather Data**: Collect relevant historical data, industry trends, and market research to ensure accuracy.

3. **Set Assumptions**: Establish logical assumptions about variables like growth rates, inflation, and market share.

4**. Choose a Modelling Approach**: Select a suitable method, such as bottom-up, top-down, or a combination.

5. **Design the Model Structure**: Organize the model into logical sections, using tools like Excel sheets or financial modeling software.

6**. Build the Model**: Construct the model, using formulas, charts, and tables to link data and calculations.

7**. Test and Validate**: Verify the model's accuracy by comparing outputs to historical data and industry benchmarks.

8. **Sensitivity Analysis:** Perform "what-if" scenarios to test the model's robustness and identify key drivers.

9. **Refine and Iterate**: Refine the model based on feedback, new data, and changing circumstances.

10. **Document and Communicate**: Clearly document the model's assumptions, methodology, and results, and present findings to stakeholders.

11**. Monitor and Update**: Regularly review and update the model to ensure ongoing relevance and accuracy.

1.10. Key Components of Financial Models

A financial model utilises several formulas and related assumptions and links these to the different components of economic models to get an idea regarding the company's future growth. Four critical elements of financial modelling help build a structure and provide a methodology for financial analysis. They are as follows:

- **Income Statement:** As the name suggests, it records all the revenues and expenses incurred by the company quarterly or annually. A simple income statement analysis will tell decision-makers whether the company is profitable or not. Companies can then make systematic adjustments in their vision and methods to arrest the losses or increase profits, as the case may be.
- **Debt Schedule:** This tells the amount of debt standing in the company's name in the form of loans, bonds and debentures. The debt schedule will offer insights

into the total interest and principal payments the company must make yearly and leverage ratio analysis.

- **Cash Flow Statement:** It records the company's cash generated and payments made towards expenses. It is one of the most essential components of financial modelling as it tells how the company is engaged in its operating, financing and investing activities.
- **Balance Sheet:** It is the most fundamental component of financial modelling and helps determine the company's financial health. A balance sheet records all assets, liabilities, capital and shareholder's equity ratio.

1.11. Advantages of Using Excel in Modelling:

- **Data-Driven Decision Making**: Improves accuracy and reduces guesswork
- **Increases Stakeholder Confidence**: Transparent and structured outputs
- **Improves Planning**: Enables testing of multiple what-if scenarios
- **Supports Fundraising**: Investors require reliable projections
- **Assists in Risk Management**: Identify best-case, worst-case scenarios
- **Time and Cost Efficiency**: Better resource allocation

1.12. DISADVANTAGES / LIMITATIONS

- **Assumption Sensitivity**: Minor changes can significantly alter results
- **Complexity**: Models can become hard to understand and maintain
- **Time-Consuming**: Initial model setup and validation require significant effort
- **Bias or Manipulation**: Can be manipulated to show favorable results
- **Skill Requirement**: Requires financial, logical, and technical skills

1.13. EVOLUTION OF FINANCIAL MODELLING

Period	Development Stage
Pre-1980s	Manual ledgers, calculators, hand-drawn models
1980s	Rise of Lotus 1-2-3 and VisiCalc spreadsheet tools
1990s	Excel becomes dominant; rise of basic macros
2000s	Complex Excel models, VBA, links to databases
2010s	Integrated modelling with BI tools and dashboards
2020s & Beyond	Real-time modelling, cloud integration, AI-based
Modern Enhancements:	• Power BI, Tableau dashboards • Python & R for financial simulation • Machine Learning for forecasting • Online collaborative platforms (Google Sheets, Office 36

1.14. Types of Financial Models:

1. Three-Statement Model: This is the most basic and widely used model. It connects the three core financial statements:

- Income Statement
- Balance Sheet
- Cash Flow Statement

The Purpose of this model is to forecast a company's complete financial picture over a period (usually 3–5 years). The Key features of this model are:

- All three statements are dynamically linked using Excel formulas.
- Includes assumptions on revenue growth, costs, capital expenditure, and working capital.
- Helps in internal budgeting, investor reporting, and business valuation.

2. Discounted Cash Flow (DCF) Model: This model estimates the intrinsic value of a business/project by projecting future cash flows and discounting them back to present

value. This model is used in valuation of companies, assets, or investments by Investment bankers, equity research analysts, PE investors. The Key Components of thus model are:

- Forecast of free cash flows (usually from a three-statement model).
- Terminal value estimation (perpetuity growth or exit multiple).
- Discounting using Weighted Average Cost of Capital (WACC).

3. Merger & Acquisition (M&A) Model: This model is used to evaluate the financial impact of one company acquiring another. The main purpose of this model is to assess whether a deal will be accretive (increase EPS) or dilutive. It is used in corporate strategy, investment banking M&A teams. The key elements of this model are

- Pro forma income statement post-merger
- Purchase price allocation
- Goodwill calculation
- Synergies and integration costs
- Debt structure and repayment plan

4. Leveraged Buyout (LBO) Model: It involves on modelling the acquisition of a company using a large amount of debt. The purpose of this model is to determine the return (IRR, MOIC) for private equity investors. The Core feature of this model is

- high debt financing,
- interest and principal repayment schedules,
- exit valuation after 3–7 years,
- equity contribution by sponsor and
- debt covenants and repayment hierarchy

5. Budgeting and Forecasting Model: This model is used for internal planning of operations and finances, usually built for 1–3 years. The objective of this model is to align goals across departments, set targets, compare actual vs budget and cash flow and cost management. This model includes activities such as

Revenue projections, cost estimates, headcount planning, capex, marketing budgets, etc.

6. Initial Public Offering (IPO) Model: This model is built when a company is planning to go public. The purpose of this model is to estimate the value of the business and determine the share price range. The key inputs of this model are

- historical and projected earnings,
- comparable company valuation,
- market sentiment and investor demand and
- ownership dilution and post-IPO capital structure

7. Real Estate Financial Model: It is used to evaluate property investment projects. It includes Construction and development costs, Rental income, occupancy rate, Loan financing, Exit value / resale value, Net operating income (NOI), Cap Rate and IRR

8. Option Pricing Model: It is used to value financial options using mathematical formulas. This model is used in Derivatives trading, risk management, investment banking. The common models under Option Pricing Models are:

- Black-Scholes Model
- Binomial Option Pricing

9. Sensitivity and Scenario Analysis Models: Built on top of existing models (like DCF or LBO) to test how changes in assumptions affect outcomes. The purpose of this model is to do Risk analysis, strategic planning, and stress testing. The various types of Sensitivity are:

- One-variable sensitivity (e.g., NPV vs discount rate)
- Two-variable sensitivity (e.g., NPV vs cost & price)
- Scenario Manager (e.g., Best-case, Base-case, Worst-case)

10. Integrated Financial Models: Complex models combining operational data, financing, and macroeconomic drivers. It is used by Multinational corporations, development finance institutions, strategic consultants. Examples include

- Infrastructure financing models
- Bank regulatory models
- ESG modelling
- Business expansion modelling

11. Working Capital Model: Focuses specifically on the working capital cycle: current assets vs current liabilities. The purpose of Working Capital model is t0 manage liquidity, cash requirements, and operational efficiency. This model includes metrics like

- Inventory turnover
- Receivables days
- Payables period
- Cash conversion cycle

1.2 Introduction to Time Value of Money (TVM)

1.2.1. Time Value Functions

The Time Value of Money (TVM) is a financial principle that states that a certain amount of money today is worth more than the same amount in the future due to its potential earning capacity. This concept is fundamental in finance and underpins various calculations related to investments, loans, and savings.

1.2.2. Key Concepts of TVM:

1. **Present Value (PV)**: The current worth of a future sum of money or cash flows, discounted at a specific interest rate. It answers the question: "How much is a future amount worth today?"

2. **Future Value (FV)**: The amount of money that an investment made today will grow to over a specific period at a given interest rate. It answers the question: "How much will my investment be worth in the future?"

3. **Interest Rates**: The cost of borrowing money or the return on investment, typically expressed as a percentage. Interest rates can be simple or compound, affecting the calculations of PV and FV.

4. **Compounding**: The process of earning interest on both the initial principal and the accumulated interest from previous periods. Compounding can significantly increase the future value of an investment.
5. **Discounting**: The process of determining the present value of future cash flows by applying a discount rate, reflecting the opportunity cost of capital.

1.2.3 Financial Functions in Excel

Excel provides various financial functions to perform TVM calculations. Here are some commonly used functions:

1.2.3.1. FV (Future Value)

- **Syntax**: FV(rate, nper, pmt, [pv], [type])
- **Description**: Calculates the future value of an investment based on periodic, constant payments and a constant interest rate.
- **Parameters**:
    - rate: The interest rate for each period.
    - nper: The total number of payment periods.
    - pmt: The payment made each period (usually a negative value).
    - pv: The present value (optional).
    - type: When payments are due (0 = end of the period, 1 = beginning; optional).

1.2.3.2. PV (Present Value)

- **Syntax**: PV(rate, nper, pmt, [fv], [type])
- **Description**: Calculates the present value of an investment based on future cash flows and a specified discount rate.
- **Parameters**: Similar to the FV function.

1.2.3.3. PMT (Payment)

- **Syntax**: PMT(rate, nper, pv, [fv], [type])
- **Description**: Calculates the payment for a loan based on constant payments and a constant interest rate.
- **Parameters**:
    - rate: The interest rate for each period.
    - nper: The total number of payment periods.
    - pv: The present value or principal.
    - fv: The future value (optional).
    - type: When payments are due (optional).

1.2.3.4. RATE

- **Syntax**: RATE(nper, pmt, pv, [fv], [type], [guess])
- **Description**: Calculates the interest rate per period of an annuity.
- **Parameters**:
    - nper: The total number of payment periods.
    - pmt: The payment made each period.
    - pv: The present value.
    - fv: The future value (optional).
    - type: When payments are due (optional).
    - guess: Your guess for what the rate will be (optional).

3.5. NPER (Number of Periods)

- **Syntax**: NPER(rate, pmt, pv, [fv], [type])

- **Description**: Calculates the number of periods for an investment or loan based on constant payments and a constant interest rate.
- **Parameters**: Similar to the PMT function.

1.2.4. Lookup Functions in Excel

Excel provides powerful lookup functions to retrieve data from arrays or tables. Here are some common lookup functions:

1.2.4.1. VLOOKUP (Vertical Lookup)

- **Syntax**: VLOOKUP(lookup_value, table_array, col_index_num, [range_lookup])
- **Description**: Searches for a value in the first column of a table and returns a value in the same row from a specified column.
- **Parameters**:
    - lookup_value: The value to search for.
    - table_array: The range of cells containing the data.
    - col_index_num: The column number from which to return the value.
    - range_lookup: TRUE for an approximate match or FALSE for an exact match (optional).

1.2.4.2. HLOOKUP (Horizontal Lookup)

- **Syntax**: HLOOKUP(lookup_value, table_array, row_index_num, [range_lookup])
- **Description**: Searches for a value in the first row of a table and returns a value in the same column from a specified row.
- **Parameters**: Similar to VLOOKUP, but works horizontally.

1.2.5. LOGICAL / CONDITIONAL FUNCTIONS:

1.2.5.1. IF Function

- **Syntax**: IF(logical_test, value_if_true, value_if_false)
- **Description**: Evaluates a logical condition and returns one value if true and another if false.
- **Parameters**:
    - logical_test: The condition to evaluate.
    - value_if_true: The value to return if the condition is true.
    - value_if_false: The value to return if the condition is false.

1.2.5.2. COUNTIF Function

- **Syntax**: COUNTIF(range, criteria)
- **Description**: Counts the number of cells within a range that meet a specific condition.
- **Parameters**:
    - range: The range of cells to count.
    - criteria: The condition that must be met.

1.2.6. Excel Built-in Financial Functions (Summary)

Function	Description	Syntax	Example
FV	Future Value	=FV(rate, nper, pmt, [pv], [type])	=FV(8%, 5, -5000, 0, 0)
PV	Present Value	=PV(rate, nper, pmt, [fv], [type])	=PV(10%, 3, -2000, 0)

Function	Description	Syntax	Example
PMT	Loan Installment (EMI)	=PMT(rate, nper, pv, [fv], [type])	=PMT(12%/12, 60, -500000)
RATE	Interest Rate	=RATE(nper, pmt, pv, [fv], [type])	=RATE(60, -10607, 500000)
NPER	No. of Periods	=NPER(rate, pmt, pv, [fv], [type])	=NPER(10%/12, -2000, 100000)

1.2.7. Lookup and Conditional Functions

Function	Description	Syntax	Example
VLOOKUP	Vertical search	=VLOOKUP(lookup_value, table_array, col_index, [range])	=VLOOKUP("A101", A1:C100, 2, FALSE)
HLOOKUP	Horizontal search	=HLOOKUP(lookup_value, table_array, row_index, [range])	=HLOOKUP("Revenue", A1:Z2, 2, FALSE)
IF	Conditional logic	=IF(condition, value_if_true, value_if_false)	=IF(A2>500, "High", "Low")
COUNTIF	Conditional count	=COUNTIF(range, criteria)	=COUNTIF(A2:A100, ">90")

1.2.8. Time Value of Money Models:

Time Value of Money (TVM) models help assess the value of cash flows over time. Here, we'll explore three key models:

- Equated Monthly Installment (EMI) with single and two interest rates,
- Loan amortization modeling, and
- Debenture redemption modelling.

Each model serves specific purposes in finance, helping individuals and businesses make informed decisions about loans and investments.

1.2.8.1.EMI Calculation (Equated Monthly Calculations)

Definition:
EMI is the fixed monthly payment made by a borrower to repay a loan over a specific period.

Structure of EMI:

- **Interest portion**: Higher in early years, decreases over time
- **Principal portion**: Increases gradually
- **Formula in Excel**:
  =PMT(rate/12, nper*12, -principal)
  - **Rate** = Annual interest rate
  - **NPER** = Total number of periods (months)
  - **Principal** = Loan amount
- **Example**: Loan: ₹2,00,000, Interest: 10% per annum, Tenure: 3 years
  =PMT(10%/12, 36, -200000) → ₹6,457.38 (monthly EMI)

1.2.8.1.1. EMI with Single Interest Rate:

In this model, the Equated Monthly Installment (EMI) is calculated for a loan at a fixed interest rate over a specific tenure. The EMI represents the monthly payment that the borrower must make to repay the loan, which includes both principal and interest. The formula for calculating EMI is:

$$\text{EMI} = \text{P} \times \left(\frac{\text{r}(1+\text{r})^{\text{n}}}{(1+\text{r})^{\text{n}} - 1} \right)$$

where:

- P= principal amount (the initial loan amount)

- r = monthly interest rate (annual interest rate divided by 12)
- n = total number of payments (loan tenure in months)

Steps:

1. Determine the principal amount, annual interest rate, and loan tenure.
2. Convert the annual interest rate to a monthly rate.
3. Apply the EMI formula to calculate the monthly installment.
4. Create an amortization schedule that shows the breakdown of each payment into principal and interest components.

Scenario: ₹5,00,000 loan at 10% p.a. for 5 years (monthly payments)

Formula Used in Excel:
=PMT(10%/12, 60, -500000)

Month	Opening Balance	EMI	Interest	Principal	Closing Balance
1	500,000	10624.68	4166.67	6457.99	493,542.01
2	493,542.01	10624.68	4112.85	6511.83	487,030.18
...	...	...	...	...	...

1.2.8.1.2. EMI with Two Interest Rates:

It is Used when loan tenure has a change in interest rate after a few years.This model involves loans that may have different interest rates over different periods (e.g., a fixed rate for the first few years and a variable rate thereafter). The EMI is recalculated when the interest rate changes, which can affect the total tenure or the amount paid in subsequent periods.

Steps:

1. Identify the periods with different interest rates and their respective rates.
2. Calculate the EMI for the first period using the initial interest rate.

3. For subsequent periods, determine the outstanding principal and recalculate the EMI based on the new interest rate.

4. Generate a revised amortization schedule reflecting the changes in payments.

Example: ₹5,00,000 loan for 5 years:

- First 2 years: 9% p.a.
- Next 3 years: 11% p.a.

Approach:

- Calculate EMI for first 2 years
- Find outstanding balance at end of year 2
- Recalculate EMI for balance with new rate for remaining years

1.2.8.2. Loan Amortization modelling:

Definition:
Amortization is the process of paying off a loan in **equal installments** where each installment includes **interest + principal**.

Meaning of Loan Amortization Modelling:

Loan amortization modeling tracks how loan payments are applied to the principal and interest over time. This model is essential for understanding how a borrower's debt decreases over the life of the loan. The amortization schedule details each payment's impact, showing how much of each installment goes toward reducing the principal versus paying interest.

Objective of Loan Amortisation Model: Track the breakdown of EMI into interest and principal.

Steps:

1. Gather the loan details, including the principal amount, interest rate, and loan term.

2. Calculate the monthly EMI using the formula mentioned earlier.

3. Create an amortization table starting with the initial loan balance. For each month, perform the following:
    - Calculate interest for the period: $Interest = Outstanding\ Principal \times r$
    - Calculate the principal repayment: $Principal\ Payment = EMI - Interest$
    - Deduct the principal repayment from the outstanding balance.
    - Repeat this process until the loan is fully amortized, showing how the balance decreases over time.

This model provides valuable insights into the cost of borrowing and helps borrowers plan their repayments effectively.

Amortization Table:

Contents of Loan Amortization Table includes:

- Opening Balance
- EMI (constant)
- Interest = Opening Balance × (Rate/12)
- Principal = EMI – Interest
- Closing Balance = Opening – Principal

Amortization helps to:

- Understand interest burden
- Plan prepayments
- Manage cash flows

Excel Functions used:

Function	Purpose	Example	Expansion of Functions
=PMT()	Calculates fixed monthly EMI	=PMT(10%/12, 36, -200000)	PMT – Total Monthly Payment

Function	Purpose	Example	Expansion of Functions
=IPMT()	Calculates interest part of EMI	=IPMT(10%/12, 1, 36, -200000)	IPMT – Interest Portion of Payment
=PPMT()	Calculates principal part of EMI	=PPMT(10%/12, 1, 36, -200000)	PPMT – Principal Portion of Payment

Formula Logic:

- EMI = same for all months → use =PMT(...)
- Interest = =IPMT(...)
- Principal = =PPMT(...)
- Closing Balance = Previous Balance – Principal

Step-by-step:

For ₹2,00,000 at 10% for 3 years:

- EMI: =PMT(10%/12, 36, -200000) → ₹6,457.38
- First month interest: =IPMT(10%/12, 1, 36, -200000) → ₹1,666.67
- First month principal: =PPMT(10%/12, 1, 36, -200000) → ₹4,790.71

1.2. 8.3. Debenture Redemption Modelling

Definition: Systematic repayment of debentures over time, either through sinking fund or lump-sum methods.

Purpose: Debenture redemption modeling focuses on the process of repaying debentures, which are long-term securities yielding a fixed interest rate. Companies typically issue debentures to raise capital and must plan for their eventual repayment. The redemption model outlines how and when the company will repay the principal amount to debenture holders.

Steps:

1. Determine the total amount of debentures issued, the interest rate, and the tenure.
2. Identify the redemption schedule, which could involve a lump-sum payment at maturity or periodic redemptions over the life of the debenture.
3. Calculate the annual interest payment: $\boldsymbol{Interest\ Payment} = \boldsymbol{Debenture\ Amount} \times \boldsymbol{Interest\ Rate}$.
4. If periodic redemption is chosen, establish a payment plan detailing how much principal will be repaid each period and how it impacts the outstanding balance.
5. Maintain a redemption schedule that includes the dates and amounts of each payment, ensuring sufficient funds are allocated to meet these obligations when they come due.

This model is essential for financial planning and ensures that a company can meet its long-term debt obligations without jeopardizing its cash flow.

Example:
A company issues ₹10,00,000 debentures for 5 years at 8% and redeems annually ₹2,00,000.

Year	Opening Balance	Redemption	Interest Paid	Closing Balance
1	10,00,000	2,00,000	80,000	8,00,000
2	8,00,000	2,00,000	64,000	6,00,000
...	...	...	...	...

CONCLUSION

Concept	Key Excel Function	Practical Use
EMI Calculation	PMT	Home loan, car loan
Future Value	FV	Investment planning

Concept	Key Excel Function	Practical Use
Present Value	PV	Bond valuation
Loan Amortization	PMT, Interest Calculation	EMI split
Lookup Functions	VLOOKUP, HLOOKUP	Dynamic models
Conditional Functions	IF, COUNTIF	Logic-based outcomes

UNIT II

2.1 Bond Valuation Modelling

2.1.1 Introduction to Bond Valuation

A bond is a fixed-income instrument that represents a loan made by an investor to a borrower. Bond valuation is the process of determining the fair price or present value of a bond, based on its expected future cash flows. Since bonds pay periodic interest (called coupon) and repay principal at maturity, their valuation is based on the concept of the Time Value of Money (TVM).

2.1.2. Key Concepts in Bond Valuation

Term	Explanation
Face Value	The amount repaid to the bondholder at maturity (usually ₹1,000).
Coupon Rate	The fixed annual interest paid (e.g., 8%).
Coupon Payment	Periodic interest payment (e.g., 8% of ₹1,000 = ₹80 annually).
Maturity	The time at which the bond's principal is repaid.
Yield to Maturity (YTM)	The internal rate of return (IRR) earned if the bond is held till maturity.
Discounting	Present valuing future cash flows using the required rate of return.

2.1.3. Types of Bonds

1. **Plain Vanilla Bonds:**
    - Also known as traditional or straight bonds.

- Offer fixed interest (coupon) payments at regular intervals and repay the principal at maturity.
- These are the most basic form of bonds with no special features.

2. **Zero-Coupon Bonds:**
   - Do not pay periodic interest (coupons).
   - Issued at a deep discount and redeemed at face value upon maturity.
   - The investor earns the difference between the purchase price and the face value.
   - Example: A bond bought for Rs. 700 and redeemed at Rs. 1,000 after 5 years.
3. **Perpetual Bonds (Consols):**
   - Bonds with no maturity date.
   - The issuer pays interest forever.
   - The principal is never repaid, making them suitable for institutions like the government.
   - Valued using the formula: Price = Coupon / YTM.
4. **Convertible Bonds:**
   - Hybrid securities that combine features of debt and equity.
   - Can be converted into a predetermined number of equity shares of the issuing company.
   - Advantageous to investors if the company's share price rises significantly.
   - Often carry lower coupon rates due to the equity upside potential.
5. **Callable Bonds:**
   - Provide the issuer with the right (but not obligation) to redeem the bond before its maturity.

- Typically callable after a specified period (e.g., 5 years).
- Usually offer a higher yield to compensate investors for reinvestment risk.

6. **Puttable Bonds:**
   - Allow the bondholder to sell the bond back to the issuer before maturity.
   - Offers protection against interest rate rises.
   - Usually have lower yields compared to callable or vanilla bonds.
7. **Inflation-Indexed Bonds:**
   - Principal and/or interest payments are linked to an inflation index (e.g., CPI).
   - Designed to protect investors from inflation risk.
8. **Floating Rate Bonds:**
   - Have variable coupon rates that adjust periodically based on a benchmark rate (e.g., LIBOR, MIBOR).
   - Suitable in volatile interest rate environments.
9. **Secured and Unsecured Bonds:**
   - Secured bonds are backed by collateral (e.g., company assets).
   - Unsecured bonds (also called debentures) rely on the issuer's creditworthiness.
10. **Junk Bonds:**
    - High-yield bonds with low credit ratings (below investment grade).
    - Carry high default risk but offer higher returns.

2.1.4. Bond Valuation Formula

a. For a standard bond:

Price of Bond = [C / (1 + r)^1] + [C / (1 + r)^2] + ... + [C / (1 + r)^n] + [F / (1 + r)^n],

where:
C = Annual coupon payment
F = Face value
r = YTM (required rate of return)
n = Number of years to maturity

b. For Zero-Coupon Bond:

Price = F / (1 + r)^n, since there are no coupon payments.

2.1.5. Yield to Maturity (YTM)

2.1.5.1. What is YTM?

- YTM is the **internal rate of return (IRR)** earned by an investor who buys the bond today and holds it until maturity.
- Yield to Maturity (YTM) is a financial metric that represents the total expected return on a bond if it is held until it matures. YTM considers all future cash flows from the bond, including periodic coupon payments and the face value repayment at maturity, and it expresses this return as an annualized rate.
- It assumes:
    - All coupons are reinvested at the same rate.
    - The bond is held till maturity.

There are two primary methods to calculate YTM: the Rate Method and the Internal Rate of Return (IRR) Method. Each method approaches the calculation differently, and understanding both can help investors make more informed decisions.

2.1.5.2 Methods of Calculating YTM:

1 Rate Method:

The Rate Method calculates YTM by using the bond pricing formula, which sets the present value of future cash flows (coupon payments and face value at maturity) equal to the bond's current market price. This method is more straightforward but often requires iterative calculations or financial calculators for accurate results

- **Formula**: The formula for a bond's price is:

$$P = t = \left(\sum_{t=1}^{N} \left(\frac{C}{(1+YTM)^t}\right) + \left(\frac{F}{(1+YTM)^N}\right)\right.$$

Where:

- P = Current market price of the bond
- C = Annual coupon payment
- F = Face value of the bond
- N = Number of years until maturity
- YTM = Yield to Maturity (unknown

Steps:

1. Identify the bond's current market price, annual coupon payment, face value, and number of years until maturity.
2. Set up the pricing equation based on the above formula.
3. Solve for YTM using financial calculators or software, as it typically requires iterative techniques (e.g., goal seek in Excel) because YTM cannot be algebraically isolated.

2. IRR Method (Excel-based)

The Internal Rate of Return (IRR) method calculates YTM by treating the bond as an investment project, where the cash inflows are the coupon payments and the face value, and the cash outflow is the bond's purchase price. This method can be

easily calculated using financial calculators or spreadsheet software, as it is designed to find the rate of return that sets the net present value (NPV) of all cash flows to zero.

Formula: The NPV of cash flows is set to zero:

$$NPV = -P + \sum_{t=1}^{N} \left(\frac{C}{(1+IRR)^t}\right) + \left(\frac{F}{(1+IRR)^N}\right) = 0$$

Where:

- P = Current market price of the bond (cash outflow)
- C= Annual coupon payment (cash inflows)
- F = Face value of the bond (cash inflow at maturity)
- IRR= Yield to Maturity (unknown)

Steps:

1. Set the cash flows based on the bond's coupon payments and the face value at maturity.
2. Use a financial calculator or Excel to input these cash flows and calculate the IRR, which corresponds to the YTM.

2.1.5.3. Example 1: Bond Valuation (YTM Method)

Given:

- Face Value = ₹1,000, Coupon Rate = 8% (₹80 per year), Market Price = ₹950, Maturity = 5 years

Using Excel IRR method

Cash Flows:

Year	Cash Flow
0	-950

Year	Cash Flow
1-4	80
5	1,080

In Excel:

=IRR({-950, 80, 80, 80, 80, 1080}) = **YTM ≈ 9.3%**

Using Rate Method in Excel:

=RATE(5,80,-950,1000) **= YTM ≈ 9.3%**

Example 2: Zero-Coupon Bond

Given:

- Face Value = ₹1,000, Maturity = 4 years, Market Price = ₹762.90

Solution:

$$\text{YTM} = \left(\frac{1000}{762.90}\right)^{1/4} - 1 = 7$$

2.1.5.4. Excel Functions for Bond Modelling

Function	Purpose
=PV(rate,nper,pmt,fv)	FInds present value of bond
=IRR(values)	Computes YTM
=PRICE()	Calculates bond price (Excel Add-in)
=YIELD()	Calculates bond yield (Excel Add-in)

2.1.5.6. Practical Bond Valuation Modelling in Excel

Example:

Inputs:

- Face Value = ₹1,000, Coupon Rate = 10%, Market Price = ₹950, Term = 3 years,
- Annual Coupon = ₹100

Cash Flow Setup:

Year	Cash Flow
0	-950
1	100
2	100
3	1,100

In Excel IRR: =IRR({-950, 100, 100, 1100})

2.1.6. Factors Affecting Bond Prices

The price of a bond is influenced by several market, economic, and bond-specific factors. Key determinants include:

1. **Interest Rates (Market Yields):**
    - Inverse relationship: When market interest rates rise, bond prices fall, and vice versa.
    - This is because existing bonds with lower coupon rates become less attractive compared to new issues.
2. **Credit Rating of the Issuer:**

- Bonds issued by companies or governments with higher credit ratings (e.g., AAA) are considered safer and attract lower yields.
- A downgrade in credit rating can reduce bond price due to perceived higher risk.

3. **Time to Maturity:**
   - Longer-duration bonds are more sensitive to interest rate changes.
   - The more distant the maturity, the greater the interest rate risk, leading to larger price fluctuations.
4. **Coupon Rate vs Market Rate:**
   - If a bond's coupon rate is higher than the current market rate, it trades at a premium.
   - If lower, it trades at a discount.
5. **Inflation Expectations:**
   - Higher expected inflation reduces the purchasing power of future bond payments, thus lowering bond prices.
   - Inflation-indexed bonds mitigate this effect.
6. **Liquidity of the Bond:**
   - More liquid bonds (easily tradable) tend to have higher prices due to lower transaction costs and quick convertibility.
   - Illiquid bonds are less attractive and are discounted.
7. **Tax Considerations:**
   - Tax treatment of interest income can affect demand.
   - Bonds offering tax-free interest may trade at a premium.
8. **Supply and Demand in the Market:**
   - High demand for bonds pushes prices up.

- Oversupply or lack of investor interest causes bond prices to drop.

9. Macroeconomic Indicators:

- GDP growth, employment data, central bank policies, and geopolitical stability influence bond markets.

10. Embedded Options:

- Features like callability or convertibility impact valuation.
- Callable bonds are less valuable to investors; puttable bonds are more valuable.

2.1.7. Bond Price vs YTM Relationship

YTM < Coupon Rate	**Price > Face Value (Premium Bond)**
YTM = Coupon Rate	Price = Face Value (Par Bond)
YTM > Coupon Rate	Price < Face Value (Discount Bond)

2.1.8. Summary of Steps for Modelling in Excel

1. List cash flows (negative purchase cost, positive coupons, and redemption).
2. Use =IRR() to calculate YTM.
3. Use =PV() to calculate bond price.
4. Use =NPV() to assess bond value at different required returns.

2.1.9. Flexi Bond YTM Modelling:

2.1.9.1 What is Flexi Bond?

Flexi Bonds are bonds that offer flexible features to investors, such as:

- Interest rate options (fixed or floating),
- Multiple maturity options (with call/put features),

- Optionality on redemption (e.g., early exit or step-up interest),
- Flexibility in coupon frequency**.**

2.1.9.2 Use in Modelling:

The focus is on YTM Modelling where coupons and/or redemption can vary, and investor has to compute the effective yield considering these variables.

Characteristics of Flexi Bonds in YTM Modelling

Feature	**Impact on YTM Modelling**
Flexible coupon schedule	May require time-adjusted PV of different coupon flows
Step-up or step-down rates	Multiple interest rates at different periods
Early redemption options	Need to estimate YTM under multiple redemption cases
Callable or puttable option	Create multiple scenarios and calculate YTM for each

2.1.9.3 Steps in YTM Modelling for Flexi Bonds –

Step 1: List All Cash Flows

- Include all coupon payments, step-up interest, and redemption amount.
- If callable/puttable, consider scenarios for each option.

Step 2: Time Index Cash Flows

- Use Year 1, 2, ..., N as cash flow periods.

Step 3: Use IRR Function in Excel

- Use the formula =IRR(range of cash flows) in Excel.

- YTM will be returned as annualised rate.

2.1.9.4 Flexi Bond YTM Excel Modelling Example

Particulars	Details
Face Value	₹1,000
Purchase Price	₹950
Tenure	5 Years
Coupon Rate	8% for Year 1–2, 9% for Year 3–5
Frequency	Annual
Redemption Value	₹1,100 (Premium ₹100)

Excel Table Format:

Year	Cash Flow (₹)
0	-950
1	80
2	80
3	90
4	90
5	90 + 1100 = 1190

Excel IRR Formula: =IRR(B2:B7)
This returns the **YTM** for the bond.

2.1.10. Strip Bond (Zero Coupon) YTM Modelling

2.1.10.1 What is a Strip Bond / Zero Coupon Bond?

A Strip Bond or Zero Coupon Bond is a type of debt instrument that:

- Does not pay periodic interest (no coupons),
- Is issued at a deep discount to face value,
- Pays only the face value at maturity.

These are typically "stripped" from a coupon-bearing bond and traded separately.

2.1.10.2. Key Features of Strip Bonds

Feature	Description
Coupon	**₹0 (No periodic interest)**
Maturity Value (FV)	**Paid at end of term**
Issued At	**Discount to face value**
Return for Investor	**Arises only from price appreciation**
Common Maturities	**1 to 30 years (long-term)**

2.1.10.3. Formula for YTM – Zero Coupon or Strip Bond

$$P = \frac{F}{(1+r)^n}$$

Rearranged to compute **YTM**:

$$r = \left(\frac{F}{P}\right)^{\frac{1}{n}} - 1$$

Where:

- P: Present Price (Market Price),

- F: Face Value (Redemption Value),
- n: Years to Maturity,
- r: Yield to Maturity (annualized).

2.1.10.4. Steps in Strip Bond YTM Modelling

Step 1: Identify Variables

- Market Price (P),
- Face Value (F),
- Time to Maturity (n in years).

Step 2: Plug into YTM Formula

- Use the above exponential formula or Excel POWER function.

2.1.10.5 Excel Modelling for YTM – Zero Coupon Bond- Example:

Particulars	**Value**
Face Value (F)	₹1,000
Market Price (P)	₹650
Tenure (n)	5 years

$$r = \left(\frac{1000}{650}\right)^{\frac{1}{5}} - 1$$

$$r = (1.5385)^{0.2} - 1 = 1.0901 - 1 = 0.0901 \text{ or } 9.01\%$$

In Excel use:
=POWER(1000/650,1/5)-1

Result: 0.0901 → **9.01% annual YTM**

2.1.10.6 Applications of Strip Bonds

- 2.Ideal for long-term planning (e.g., education, retirement),
- Used for duration matching in portfolio management,
- Preferred in low-cash-flow environments (no interim payments).

2.1.10.7. Advantages and Disadvantages

Advantages	Disadvantages
Simple and predictable	No regular income
Immune to reinvestment risk	Sensitive to interest rate changes
Long-term capital appreciation	Marketability may be lower

2.1.10.8 COMPARISON OF FLEXI BONDS AND STRIP BONDS YTM MODELING

Feature	Flexi Bonds	Strip Bonds
Definition	Bonds with flexible coupon payments that can change over time based on market conditions or the issuer's discretion.	Bonds that separate the principal and interest payments into individual securities, allowing them to be traded separately.
Cash Flow Structure	Cash flows can vary due to changes in interest rates; payments are made periodically.	Cash flows are fixed and predictable; separate securities for each coupon payment and principal repayment.
YTM Calculation	YTM is calculated based on expected future cash flows, considering the variability of coupon payments. May require adjustments for changing cash flows.	YTM is calculated based on the fixed cash flows from the separated securities. Each payment has a known amount and timing, making calculation straightforward.

Market Price Sensitivity	More sensitive to interest rate fluctuations due to variable cash flows.	Less sensitive to interest rate changes, as cash flows are fixed and known in advance.
Investor Suitability	Suitable for investors looking for potentially higher returns and willing to accept variability in cash flows.	Suitable for investors seeking predictable cash flows and lower risk, often used for hedging or income strategies.
Risk Profile	Higher risk due to uncertainty in cash flows and dependence on market conditions.	Lower risk profile, as cash flows are known and predictable.
Reinvestment Assumption	Assumes reinvestment at variable rates, reflecting market changes.	Assumes reinvestment at the same YTM rate, reflecting fixed cash flows.
Example Use Case	Corporate bonds where coupon payments can be adjusted based on company performance or prevailing interest rates.	Government bonds converted into zero-coupon bonds, where investors buy the principal and each interest payment separately.

2.1.11. Bond Redemption Modelling:

Bond redemption modelling refers to the process of analyzing and planning for the repayment of bonds at maturity or at specific intervals if the bonds are callable or have sinking fund provisions. This modelling helps issuers and investors understand the financial implications of bond repayment, including cash flow management, interest expense, and the overall cost of debt. Here's a breakdown of the bond redemption modelling process in seven key steps:

2.11.1 Bond Redemption Modelling Process

Step1 Define Bond Characteristics:

Gather essential information about the bond, including the face value (par value), coupon rate, maturity date, issue date payment frequency, and any call or redemption provisions. This information is crucial for accurate modelling.

Step 2: Determine Cash Flow Schedule:

Create a detailed schedule of cash flows associated with the bond. This includes coupon payments and the repayment of the principal at maturity. If the bond is callable or has a sinking fund, outline any early redemption scenarios as well.

Step 3: Assess Market Conditions:

Evaluate current and projected market interest rates, credit spreads, and economic conditions that could affect the bond's redemption and refinancing decisions. Understanding the Market environment helps in anticipating cash flow needs,

Step 4: Calculate Interest Expense

Determine the total interest expense over the life of the bond. This includes periodic coupon payments and any additional costs associated with redeeming the bond early if applicable. Consider the impact of changes in interest rates on the total expense.

Step 5: Model Redemption Scenarios:

Develop various redemption scenarios based on different interest rate environments, refinancing options, and strategic decisions. This may include modelling early redemptions if market conditions are favourable. Analyse how these scenarios impact cash flows and overall costs

Step 6: Evaluate Financial Impact:

Assess the financial implications of each redemption scenario on cash flow, net present value (NPV), and overall capital structure. Consider the effect of redeeming bonds early on the company's liquidity, credit ratings, and future borrowing capacity.

Step 7: Decision-Making and Reporting:

Make informed decisions regarding bond redemption based on the modelling analysis. Present the findings to stakeholders, including management and investors, highlighting the risks and benefits of each redemption scenario. This step often involves recommendations for optimal redemption strategies.

Example:
Price = ₹950, Coupon = ₹80, FV = ₹1050 (Premium), Tenure = 5 years

Cash Flows: -950, 80, 80, 80, 80, 1130
In Excel

Year	Cash Flow
0	-950
1	80
2	80
3	80
4	80
5	1130

Excel Formula: =IRR(B1:B6) → YTM = **10.85%**

2.2.EQUITY SHARE VALUATION MODELLING

2.2.1. Introduction to Equity Share Valuation:

Equity share valuation is an essential process in financial modelling that determines the intrinsic value of a company's shares. One common method is the Multiple Growth Rate Valuation, which can be performed both with and without growth rates. This method is particularly useful for evaluating companies with varying growth phases or for those in different industries.

Equity share valuation helps to determine the intrinsic value of a company's shares using expected future dividends or earnings. The most commonly used models are:

- **Constant Growth Dividend Discount Model (Gordon Growth Model)**
- **Multiple Growth Rate Models** (Two-stage or Three-stage models)

2.2.1.1. Valuation with Growth Rates

Process: In this approach, we incorporate expected growth rates into the valuation model, allowing for a more accurate representation of a company's future cash flows. The model typically uses the **Discounted Cash Flow (DCF)** method, projecting cash flows based on expected growth rates over a specific period before stabilizing at a terminal growth rate.

Steps:

1. **Estimate Future Cash Flows**: Begin by forecasting the company's future cash flows for a defined period (usually 5-10 years). This involves analyzing historical financial data, market trends, and management guidance to project revenues, operating income, and free cash flows.
2. **Assign Growth Rates**: Apply different growth rates for each year based on the company's expected performance. For example, the company might experience high growth in the first few years, followed by a decline as it matures.

3. **Calculate Present Value of Cash Flows**: Discount the projected cash flows back to the present value using an appropriate discount rate (often the company's Weighted Average Cost of Capital, WACC). This reflects the time value of money.
4. **Determine Terminal Value**: At the end of the forecast period, calculate the terminal value using either the Gordon Growth Model (assuming perpetual growth) or an exit multiple. This represents the value of all future cash flows beyond the forecast period.
5. **Sum Present Values**: Add the present value of the forecasted cash flows and the present value of the terminal value to arrive at the total enterprise value.
6. **Adjust for Debt and Equity**: Subtract any outstanding debt to determine the equity value of the company. Finally, divide by the number of shares outstanding to get the intrinsic value per share.

This method provides a nuanced view of a company's potential value by incorporating varying growth expectations and is particularly effective for high-growth or cyclical companies.

2.2.1.1.1. Constant Growth Dividend Discount Model (Gordon Model)

Formula:

$$P_0 = \frac{D_1}{r - g}$$

Where:

- P0: Present value of the share (today's price)
- D1: Dividend expected next year
- r: Required rate of return (cost of equity)
- g: Constant dividend growth rate

Assumptions:

- The company grows at a constant rate indefinitely.
- Dividend payout and return expectations remain stable.

2.2.1.1.2. Multi-Stage (Two-Stage) Growth Model

Used when:

- Company grows at a **higher rate initially** (e.g., 3–5 years),
- Then settles into a **lower, stable growth rate** thereafter.

Step-by-Step Formula:

1. **Estimate dividends** for high-growth years: D1,D2,...,Dn
2. **Calculate terminal value (TV)** at the start of the stable growth phase using the Gordon model:

$$TV = \frac{D_{n+1}}{r - g}$$

3. Discount all future cash flows (dividends + terminal value) to the present value

using:

$$PV = \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \cdots + \frac{TV}{(1+r)^n}$$

2.2.1.2 Valuation without Growth Rates

Process: This approach assumes a constant growth rate or no growth for simplicity. It's often utilized for mature companies or those in stable industries where future cash flows are predictable and do not exhibit significant fluctuations.

Steps:

1. **Estimate Stable Cash Flows**: Start by determining the company's current cash flows, often using free cash flow from the most recent fiscal year as a baseline. This may involve normalizing cash flows for one-time events or irregular income.
2. **Assume Constant Growth or No Growth**: Decide on a growth rate to apply to future cash flows. This can be a modest fixed growth rate, such as the rate of inflation, or a zero-growth assumption for companies with stable revenues.
3. **Calculate Present Value of Cash Flows**: Similar to the previous method, discount the future cash flows back to the present value using an appropriate discount rate.
4. **Determine Terminal Value**: If applicable, calculate a terminal value based on the same constant growth assumption, reflecting the long-term sustainability of cash flows.
5. **Sum Present Values**: Combine the present value of the cash flows and terminal value to arrive at the total enterprise value.
6. **Adjust for Debt and Equity**: Subtract any debt to arrive at the equity value, and divide by shares outstanding for intrinsic value per share.

2.2.2. Excel Tips for Equity Valuation

Function	Purpose	Example
=PV()	Find present value of future cashflows	=PV(10%, 3, 0, -127.68)
=NPV()	Use for multiple year dividend flows	=NPV(10%, D1:D3) + PV(Terminal)
=FV()	Future value of a growing dividend	=FV(growth rate, years, 0, -initial dividend)

Problem 1 – Constant Growth Model

Question:
A firm paid ₹5 as dividend this year and expects to grow at 6% annually. If the required return is 12%, find the intrinsic value of the share.

Solution:

1. D1=5×(1+0.06)=5.30
2. P0=5.30/(0.12−0.06)=₹88.33

=D1/(r - g) Where:

- D1 = 5.3
- r = 0.12
- g = 0.06

Problem 2 – Two-Stage Growth Model

Question:
A company pays ₹4 in dividends now. It will grow at 15% for 3 years, then at 5% forever. Required return is 10%. Calculate intrinsic value.

- **Step-by-step:**

Year	Dividend (₹)	Present Value Formula	PV (₹)
1	4 × 1.15 = 4.60	4.60 / (1.10)^1	4.18
2	4.60 × 1.15 = 5.29	5.29 / (1.10)^2	4.37
3	5.29 × 1.15 = 6.08	6.08 / (1.10)^3	4.57
TV	6.08 × 1.05 / (0.10 - 0.05) = 127.68	127.68 / (1.10)^3	95.87
Total P_0			**₹108.99**

In Excel:

=PV(10%,1,,4.60) + PV(10%,2,,5.29) + PV(10%,3,,6.08) + PV(10%,3,,127.68)

UNIT 3
3.1 CORPORATE MODELLING

3.1.1.1 Introduction to Bankruptcy Prediction

- **Importance:** Early detection of financial distress allows management, investors, and creditors to take corrective actions or mitigate losses.
- **Qualitative vs. Quantitative Factors:**
    - **Qualitative:** Management quality, industry trends, legal environment, competition.
    - **Quantitative:** Financial ratios, statistical models (like Z-score).

3.1.1.2 Altman Z-Score Model

Altman Z-Score and Bankruptcy Modelling:

- The **Altman Z-Score** is a financial formula used to assess the likelihood of a company entering bankruptcy within the next two years. Developed by Edward Altman in the 1960s, the Z-Score combines various financial ratios to provide a single score that categorizes a company into one of three zones: safe, gray (some risk), or distressed (high risk of bankruptcy).
- **Objective:** To understand how quantitative models, specifically the Altman Z-Score, are used to predict corporate financial distress and bankruptcy, and to interpret their results for decision-making.
- **Developed by:** Edward I. Altman in 1968. It's a multivariate financial formula that uses five common business ratios to measure the financial health of a company and predict the probability of bankruptcy.
- **Original Formula (for Public Manufacturing Firms):**

$$Z=1.2A+1.4B+3.3C+0.6D+1.0E$$

Where:

- **A = Working Capital / Total Assets:** Measures liquidity and asset size. A higher ratio indicates more liquid assets relative to total assets, suggesting better financial health.

- **B = Retained Earnings / Total Assets:** Measures profitability and age of the company. A higher ratio indicates a company has reinvested more earnings, suggesting financial stability.
- **C = Earnings Before Interest and Taxes (EBIT) / Total Assets:** Measures operating efficiency or asset productivity. A higher ratio indicates better ability to generate profit from assets before financing and tax costs.
- **D = Market Value of Equity / Total Liabilities:** Measures leverage. A higher ratio indicates a stronger equity cushion relative to debt, suggesting lower bankruptcy risk.
    - Market Value of Equity = (Share Price * Number of Outstanding Shares)
- **E = Sales / Total Assets:** Measures asset turnover (efficiency of assets in generating sales). A higher ratio indicates more efficient asset utilization.

3.1.1.3 Interpretation of Z-Score:

- **Z > 2.99:** "Safe Zone" - Low probability of bankruptcy.
- **1.81 < Z < 2.99:** "Grey Zone" - Moderate probability of bankruptcy. Caution is advised.
- **Z < 1.81:** "Distress Zone" - High probability of bankruptcy.

3.1.1.4 Variants of Altman Z-Score:

- **Z'-Score (for Private Manufacturing Firms):** Modified formula because market value of equity might not be readily available for private companies. Book value of equity is often used instead of market value in ratio D.
    - Formula coefficients are typically adjusted. (e.g., Z'=0.717A+0.847B+3.107C+0.420D+0.998E, where D uses book value of equity).

- **Z''-Score (for Non-Manufacturing / Service Firms):** Another modification, often removing the Sales/Total Assets ratio (E) as it may not be as relevant for service companies, and adjusting coefficients.
    - (e.g., Z''=6.56A+3.26B+6.72C+1.05D, where D uses book value of equity).

3.1.1.5 Bankruptcy Modeling Process Using Altman Z-Score

The process of bankruptcy modeling using the Altman Z-Score involves several key steps:

Step	Description
1. Data Collection	Gather the necessary financial data from the company's financial statements, including balance sheets and income statements. Key components are total assets, working capital, retained earnings, EBIT, market value of equity, and total liabilities.
2. Calculate Financial Ratios	Compute the necessary financial ratios as per the Z-Score formula, ensuring accurate and up-to-date data is used for each component.
3. Compute the Z-Score	Apply the Z-Score formula using the calculated ratios to derive a single score that indicates the company's financial health.
4. Analyze the Score	Compare the Z-Score to the thresholds (safe, gray, distress) to assess the company's risk of bankruptcy. Consider the broader economic context and industry-specific factors that may affect interpretation.
5. Scenario Analysis	Perform sensitivity analysis by adjusting key inputs to understand how changes in financial performance might impact the Z-Score. This can include examining the effects of declining sales, increased debt, or reduced margins.
6. Monitor Changes	Regularly update the analysis to reflect changes in financial performance or economic conditions. Continuous monitoring helps identify early warning signs of financial distress.
7. Decision Making	Use the insights gained from the Z-Score analysis to inform strategic decisions. This may include restructuring, seeking additional financing, or operational changes to mitigate bankruptcy risk.

3.1.1.6 Limitations of Altman Z-Score:

- **Historical Data:** Based on past financial data, which may not accurately predict future performance.
- **Industry Specificity:** Original model designed for manufacturing firms; variants exist but still may not capture nuances of all industries.
- **Static Measure:** A single point-in-time snapshot, doesn't capture dynamic changes.
- **Manipulation of Financials:** Ratios can be manipulated to show a healthier picture.
- **Not a Guarantee:** A high Z-score doesn't guarantee solvency, nor does a low score guarantee bankruptcy. It's a predictive tool, not a definitive one.
- **New Companies:** Less applicable to young companies with limited retained earnings.

3.1.1.7: Modelling Considerations

- **Data Collection:** Accurate and consistent financial data from annual reports.
- **Sensitivity Analysis:** Understand how changes in input ratios impact the Z-score.
- **Trend Analysis:** Track Z-score over time to identify improving or deteriorating financial health.

3.1.2: Indifference Point Modelling

In corporate financial modelling, **indifference point modelling** (also known as the indifference level of EBIT or EBIT-EPS indifference point) is used to determine the level of Earnings Before Interest and Taxes (EBIT) at which two different financing options result in the same Earnings Per Share (EPS). It helps a company decide between two financing alternatives—such as debt financing versus equity financing—by evaluating the impact of each on the firm's profitability.

The **Indifference Point (IP)** is the level of **EBIT (Earnings Before Interest & Taxes)** where two financing options or business plans yield the **same Earnings**

Per Share (EPS).
It helps management decide between:

- Different financing methods (debt vs equity)
- Different projects or operational plans

3.1.2.1: Introduction to Capital Structure

- **Definition:** The mix of debt and equity used to finance a company's assets.
- **Objective:** To find the optimal capital structure that minimizes the cost of capital and maximizes shareholder wealth.
- **Financing Alternatives:** Issuing equity shares, taking on debt (loans, debentures), or issuing preference shares.

3.1.2.2: Key Concepts:

- **Earnings Before Interest and Taxes (EBIT):** This is the operating profit of the company before interest and taxes.

- **Earnings Per Share (EPS):** A financial measure that indicates the profitability available to shareholders, calculated as:

$$\textbf{EPS} = \frac{\textbf{Net Income}}{\textit{Number of Outstanding Shares}}$$

- **Capital Structure Options:** This could be debt financing (where a company borrows money and pays interest) or equity financing (where a company raises funds by issuing shares, diluting ownership).

3.1.2.3: Process involved in indifference point modelling:

Indifference point modeling in corporate financial modeling helps in determining the point at which a company is indifferent between two financing options (like debt and equity). This approach involves the following steps:

1. Identify the Financing Options

First, define the two financing alternatives, such as issuing debt or equity, and their associated costs, including interest rates, tax impacts, or dilution effects on ownership. Each financing method impacts the firm's cost structure differently, affecting net income or cash flows.

2. Determine the Cost Structure

Establish fixed and variable costs for each option. Debt financing, for instance, includes fixed interest costs, while equity financing may result in dividend payments. These costs are crucial to understanding how changes in financial structure influence overall financial performance.

3. Set Up the Earnings Before Interest and Taxes (EBIT) Range

Calculate a range of EBIT values for the firm, which helps in analyzing how each financing option performs under different operational scenarios. The EBIT represents operating profit before considering interest payments or taxes.

4. Calculate the Net Income for Each Option

Using the EBIT range, compute the net income or earnings after taxes for both financing options. Include interest payments for debt and dividends (if applicable) for equity. Net income allows you to see the profitability under both choices. Create an equation where the costs or benefits of the two options are equal:

- **For Financing**:
  Total Cost of Debt Financing = Total Cost of Equity Financing
- **For Investment Projects**:
  Cost/Benefit of Project A = Cost/Benefit of Project B
- **For debt-equity financing decisions**:
  Cost of Debt = Cost of Equity

5. Find the Indifference Point

The indifference point is the EBIT value at which the net income under both financing options is the same. Mathematically, this is done by equating the net income equations for both options and solving for EBIT. This point shows where either financing option yields the same financial benefit.

6. Analyze and Interpret

Once the indifference point is found, analyze it in the context of your company's expected EBIT. If your projected EBIT is above or below the indifference point, you can decide which financing option is more advantageous, helping optimize the financial structure.

3.1.2.4 FORMULAS USED IN INDIFFERENCE POINT

Formula for Indifference Point (EBIT):

$$EBIT_{\text{indifference}} = \frac{EPS_2 - EPS_1}{Slope_1 - Slope_2}$$

Where slope = change in EPS per unit change in EBIT.

For two plans (say A & B) with EPS formulas:

$$EPS_A = \frac{EBIT - Interest_A}{Shares_A}$$

$$EPS_B = \frac{EBIT - Interest_B}{Shares_B}$$

Set $EPS_A = EPS_B$ to find **EBIT at indifference**.

3.1.2.5. Step-by-Step Excel Modelling

Step 1: Setup Data Table

Create a table in Excel:

EBIT (₹)	Interest A (₹)	Shares A	EPS A	Interest B (₹)	Shares B	EPS B
0	10000	1000		5000	1200	
100000	10000	1000		5000	1200	
200000	10000	1000		5000	1200	
300000	10000	1000		5000	1200	

Step 2: EPS Calculation

EPS = (EBIT−Interest)/Shares

In Excel:

- For Plan A: = (B2 - C2) / D2
- For Plan B: = (B2 - E2) / F2

Drag the formula down for all EBIT values.

Step 3: Chart the EBIT–EPS

1. Highlight EBIT, EPS A, and EPS B columns.
2. Insert → Scatter Plot → Lines.
3. You will see **two lines intersect**; the intersection is the **indifference point**.

Step 4: Using Goal Seek

1. Go to **Data → What-If Analysis → Goal Seek**
2. Set:
    - **Set cell:** EPS A
    - **To value:** EPS B (the cell reference)
    - **By changing cell:** EBIT
3. Click OK → Excel will give **EBIT at indifference**.

Step 5: Extend to 3 Plans

- Add **Plan C** column and EPS formula.
- Repeat the Goal Seek or chart to identify pairwise indifference points.
- Use these points to decide **which plan is better above or below each EBIT level**.

3. Key Notes

- Higher debt increases EPS sensitivity (higher slope).
- Lower debt reduces risk but may lower EPS potential.
- Indifference Point tells **exact EBIT where choices are neutral**; management can make strategic decisions beyond this point.

3.1.2.6 Managerial Implications:

- If expected EBIT is above the indifference point, the plan with higher financial leverage (more debt) will result in higher EPS.
- If expected EBIT is below the indifference point, the plan with less financial leverage (more equity) will result in higher EPS.
- This model helps in choosing the optimal capital structure based on expected earnings.

3.1.3: Financial Break-Even Modelling

Objective: To determine the minimum level of sales or production required to cover all costs (fixed and variable) and achieve a target profit (often zero profit, i.e., just covering costs).

3.1.3.1 Introduction to Break-Even Analysis

- **Definition:** A cost-volume-profit (CVP) analysis tool that examines the relationship between costs, sales volume, and profit.
- **Purpose:** The Purpose of Financial Break-Even Modelling is to understand:
    - The minimum level of sales or production required to avoid losses.

- The impact of changes in costs (fixed or variable), sales price, or sales volume on profitability.
- The safety margin available before the company starts incurring losses.

3.1.3.2 Components of Break-Even Analysis:

- **Fixed Costs (FC):** Costs that do not change with the level of production (e.g., rent, salaries of administrative staff, depreciation).
- **Variable Costs (VC):** Costs that change directly with the level of production (e.g., raw materials, direct labour, sales commission).
- **Selling Price Per Unit (P):** The price at which each unit is sold.
- **Contribution Margin Per Unit (CM):** The amount each unit sold contributes towards covering fixed costs and generating profit (CM=P−VC unit).
- **Contribution Margin Ratio (CMR):** The percentage of each sales rupee that contributes to covering fixed costs and generating profit (CMR=CM/P).

3.1.3.3 Break-Even Point (BEP)

- **Definition:** The level of sales (in units or rupees) at which total revenue equals total costs (fixed costs + variable costs), resulting in zero profit.
  - **Break-Even Point in Units (BEP units):**

$$BEP_{units} = \frac{FixedCosts}{SellingPricePerUnit - VariableCostPerUnit} = \frac{FC}{CM_{unit}}$$

  - **Break-Even Point in Sales Value (BEP rupees):**

$$BEP_{rupees} = \frac{FixedCosts}{ContributionMarginRatio} = \frac{FC}{CMR}$$

Or, $BEP_{rupees} = BEP_{units} * P$

3.1.3.4 Financial Break-Even Point (beyond accounting break-even):

- While the basic break-even focuses on covering operational costs, the **financial break-even point** can be extended to consider the minimum EBIT required to cover fixed financial charges (like interest and preference dividends) *in addition* to operating fixed costs.
- **Focus:** Ensuring the company generates enough profit to meet its financial obligations before considering equity returns.
- **Target Profit Break-Even:** You can modify the break-even formula to achieve a target profit (including covering fixed financial charges as a "target profit").

$$Units\ to\ achieve\ Target\ Profit = \frac{Fixed\ Costs + Target\ Profit}{CM_{unit}}$$

  - Here, "Target Profit" could encompass the required interest payments and preference dividends, potentially after tax adjustments.

3.1.3.5 Managerial Implications & Modelling:

- **Feasibility Analysis:** Helps assess the viability of a new product or project.
- **Pricing Decisions:** Determines the impact of price changes on sales volume needed.
- **Cost Control:** Highlights the importance of managing fixed and variable costs.
- **Sensitivity Analysis:** Model different scenarios (e.g., what if variable costs increase by 10%? What if sales price drops?).
- **Margin of Safety:** The difference between actual or expected sales and the break-even sales. A higher margin of safety indicates lower risk.

3.1.3.6: PROCESS INVOLVED IN DEVELOPING MODEL FOR FINANCIAL BREAK-EVEN MODELLING

- **Identifying Fixed and Variable Costs**: Start by classifying all the company's costs into fixed (those that do not change with the level of production, such as rent or salaries) and variable costs (those that fluctuate with production levels, such as raw materials). This step is essential to understanding cost behavior.
- **Estimating Unit Selling Price and Variable Costs per Unit**: Determine the selling price of the product or service and the variable cost per unit. These figures help calculate contribution margin, which is key to finding the break-even point.
- **Calculating Contribution Margin**: The contribution margin is the difference between the selling price per unit and the variable cost per unit. It represents how much of each sale is available to cover fixed costs after paying variable costs.
- **Determining Total Fixed Costs**: Calculate the total fixed costs, which remain constant regardless of production levels. This could include overhead, depreciation, and certain administrative costs.
- **Break-even Point Calculation**: Divide total fixed costs by the contribution margin to calculate the break-even point in units. This is the number of units the company must sell to cover all its fixed and variable costs without making a profit or a loss.
- **Sensitivity Analysis**: Finally, perform a sensitivity analysis to understand how changes in key inputs (such as costs, price, or sales volume) affect the break-even point. This step helps assess risk and make informed decisions.

3.1.4: Corporate Valuation Modelling (Two-Stage Growth):

Two-Stage Growth Model in corporate valuation is a method used to estimate the value of a company based on the assumption that it will experience two distinct growth phases: an initial high-growth phase, followed by a stable, lower-growth phase. This approach is commonly applied when valuing companies that are expected to grow rapidly in the near term but eventually stabilize as they mature.

Objective: To apply advanced Discounted Cash Flow (DCF) models, specifically the two-stage growth model, to value an entire corporation, moving beyond simple dividend-based approaches.

3.1.4.1 Introduction to Corporate Valuation

- **Definition:** Estimating the intrinsic value of a company.
- **Key Idea:** The value of a company is the present value of its expected future cash flows.
- **Methods:**
    - **Discounted Cash Flow (DCF):** Free Cash Flow to Firm (FCFF) or Free Cash Flow to Equity (FCFE).
    - **Relative Valuation:** Using multiples (P/E, EV/EBITDA, etc.).
    - **Asset-Based Valuation.**

3.1.4.2 Free Cash Flow to Firm (FCFF)

- **Definition:** Cash flow available to all capital providers (debt and equity holders) after all operating expenses and necessary investments (capital expenditures, working capital) have been made.
- **Formula:**

$$FCFF = EBIT * (1 - T) + Depreciation - Capital\ Expenditures - \Delta Working$$

Or,

$$FCFF = Net\ Income + Non - cash\ Charges + Interest\ Exp.(1 - T) - CapEx$$

- **Discount Rate:** Weighted Average Cost of Capital (WACC)

3.1.4.3 Two-Stage FCFF Valuation Model

- **Concept:** Assumes a period of high growth (Stage 1) followed by a period of stable, perpetual growth (Stage 2). More realistic than single-stage models.
- **Steps:**

1. **Forecast FCFF in the High Growth Phase (Explicit Forecast Period):**
    - Project revenues, operating expenses, taxes, depreciation, capital expenditures, and working capital changes for each year in the high-growth period (e.g., 5-10 years).
    - Calculate FCFF for each year.
2. **Calculate the Present Value of High Growth FCFFs:** Discount each FCFF back to time zero using the WACC.
3. **Calculate the Terminal Value (TV) at the end of the High Growth Phase:**
    - This represents the value of all FCFFs beyond the explicit forecast period, assuming a stable, perpetual growth rate (gs).
    - Use the Gordon Growth Model for TV:

$$TV_N = \frac{FCFF_{N+1}}{WACC - g_s}$$

Where $FCFF_{N+1}$ is the first FCFF in the stable growth phase (i.e., $FCFF_N * (1 + g_s)$).

- **Assumptions for Stable Growth:**
    - gs should be sustainable (usually not exceeding nominal GDP growth).
    - Capital expenditures should offset depreciation in the long run (CapEx ≈ Depreciation).
    - Working capital changes should be stable.

4. Discount the Terminal Value: Discount the TVN back to time zero using WACC.

$$PV(TV_N) = \frac{TV_N}{(1 + WACC)^N}$$

5. Sum the Present Values: Add the present value of high-growth FCFFs and the present value of the terminal value to get the **Value of the Firm**.

$$Value\ of\ Firm = \sum_{t=1}^{N} \frac{FCFF_t}{(1+WACC)^t} + \frac{TV_N}{(1+WACC)^N}$$

6. Calculate Value of Equity:

Value of Equity=Value of Firm−Market Value of Debt

7. Calculate Intrinsic Value Per Share:

$$Intrinsic\ Value\ Per\ Share = \frac{Value\ of\ Equity}{Number\ of\ Shares\ Outstanding}$$

3.1.4.4 Key Inputs and Modelling Considerations:

- **Revenue Growth:** Crucial assumption, often driven by market size, market share, pricing.
- **Operating Margins:** Efficiency of operations.
- **Capital Expenditures (CapEx):** Investments in fixed assets for growth and maintenance.
- **Working Capital Changes:** Investments in current assets (inventory, receivables) less current liabilities (payables) to support growth.
- **Tax Rate:** Effective tax rate.
- **WACC (Weighted Average Cost of Capital):** The discount rate, reflecting the overall cost of financing for the company.

$$WACC = (E/V) * R_e + (D/V) * R_d * (1 - T)$$

Where

  - Re is Cost of Equity (e.g., from CAPM),
  - Rd is Cost of Debt.
- **Stable Growth Rate (gs):** A long-term, sustainable growth rate. Usually conservative.
- **Sensitivity Analysis:** Critical to test how changes in key assumptions (growth rates, WACC, terminal growth) affect the valuation.

3.1.4.5 Process involved in Corporate Valuation:

Corporate valuation using a two-stage growth model is a popular approach in corporate financial modeling. This method assumes a company experiences two distinct growth phases: a high-growth phase followed by a stable growth phase. Below are the seven key processes involved:

1. **Historical Data Collection**: Gather financial statements (income, balance sheet, and cash flow) and performance metrics of the company. This data helps to assess the company's past trends and forms a foundation for projecting future performance.
2. **Revenue and Expense Forecasting**: Project the company's future revenue and expenses based on assumptions about the company's growth rate in the first stage (high growth phase). This phase typically sees rapid expansion driven by market share gains or new product launches. Expense projections are made in line with the revenue growth.
3. **Determining Growth Phases**: Define the two growth stages. The first phase represents a period of high growth where the company expands faster than the overall market. The second stage assumes growth will taper off to a stable, mature rate, usually in line with the long-term growth of the economy or the industry.
4. **Free Cash Flow (FCF) Estimation**: Estimate the Free Cash Flow during both the high-growth and stable-growth phases. FCF is calculated by subtracting capital expenditures and working capital investments from the operating cash flow. It reflects the company's true profitability and its ability to return value to shareholders.
5. **Terminal Value Calculation**: The terminal value captures the value of the company at the end of the high-growth phase, continuing indefinitely into the stable growth period. This is typically calculated using the Gordon Growth Model, assuming a perpetual growth rate for the stable phase.
6. **Discounting Cash Flows**: The projected free cash flows from both the high-growth and stable phases, along with the terminal value, are discounted back

to the present using the Weighted Average Cost of Capital (WACC). The discounting accounts for the time value of money and risk.

7. **Summing and Sensitivity Analysis**: The final corporate valuation is derived by summing the discounted free cash flows and the discounted terminal value. Sensitivity analysis is often performed to test how changes in key assumptions (e.g., growth rate, WACC, terminal growth rate) affect the valuation, ensuring robustness.

3.2: BUSINESS MODELLING FOR CAPITAL BUDGET EVALUATION

Business modelling for capital budgeting evaluation involves several techniques to assess the viability of investment projects. Among the most widely used methods are the Payback Period, Net Present Value (NPV), Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR).

3.2.1: Business Modelling for Capital Budgeting Evaluation: Payback Period, NPV, IRR, and ARR

- **Definition:** The process of planning and managing a firm's long-term investments, such as new projects, expansion of existing facilities, or acquisition of new equipment.
- **Objective:** To model and evaluate capital expenditure projects using various appraisal techniques, understanding their strengths and weaknesses for decision-making.
- **Importance:**
    - Involves large cash outlays.
    - Long-term implications (irreversibility).
    - Impacts profitability and future growth.
- **Steps:**
    1. Generate investment proposals.
    2. Estimate cash flows (initial outlay, operating cash inflows, terminal cash flow).
    3. Evaluate proposals using appraisal techniques.
    4. Select projects.

5. Implement and review.

3.2.1.2 Cash Flow Estimation (Crucial for all DCF methods)

- **Initial Outlay:** Purchase price of asset, installation costs, initial working capital.
- **Operating Cash Inflows (After-Tax):**
  - Cash Inflow=(Revenue−Operating Costs−Depreciation)∗(1−T)+Depreciation
  - Or, Cash Inflow=(EBIT∗(1−T))+Depreciation (if only interested in operating cash flow before interest)
  - Focus on incremental cash flows.
- **Terminal Cash Flow:** Salvage value (after tax effects), recovery of working capital.

3.2.1.3 Evaluation Techniques (Modelling in Excel/Software is common)

A. Non-Discounting Methods (Ignore Time Value of Money):

- **1. Payback Period (PBP)**: Payback period calculates the time it takes for an investment to generate cash flows equal to the initial investment. It provides a simple measure of liquidity and risk but does not consider the time value of money or cash flows beyond the payback period.

  - **Calculation:**

  a) when cash inflows are equal:

$$PBP = \frac{Initial\ investment}{Average\ Cash\ flows}$$

  b) when cash inflows are not equal:

$$\textbf{PBP=No. of years+} \left(\frac{\textbf{Initial Investment-Cumulative cash inflow}}{\textbf{Cash inflow of next year}}\right)$$

  - **Decision Rule:** Accept projects with a payback period shorter than a predetermined maximum acceptable period.

- **Advantages:** Simple to understand and calculate, useful for assessing liquidity risk.
- **Disadvantages:** Ignores time value of money, ignores cash flows beyond the payback period, does not directly measure profitability.
- **Modelling:** Set up a table with years, cash flows, and cumulative cash flows. Identify the year in which cumulative cash flow turns positive.

- **2. Accounting Rate of Return (ARR) / Average Rate of Return (ARR)**
  - **Definition:** Measures the project's average annual accounting profit as a percentage of the average investment.
  - **Formula:**

$$ARR = \frac{Average\ Annual\ Net\ Income}{Average\ Investment} * 100$$

- $Average\ Investment = (Initial\ Investment + Salvage\ Value)/2$

  - **Decision Rule:** Accept projects with an ARR greater than or equal to a predetermined target rate.
  - **Advantages:** Simple to calculate, uses accounting profit which is familiar.
  - **Disadvantages:** Ignores time value of money, based on accounting profit (not cash flow), sensitive to depreciation method.
  - **Modelling:** Calculate average net income (after tax and depreciation) and average investment.

B. Discounting Methods (Consider Time Value of Money):

- **3. Net Present Value (NPV)**
  - **Definition:** The difference between the present value of a project's future cash inflows and the present value of its initial investment (cash outflows).
- NPV measures the present value of all cash inflows and outflows of an investment discounted at a specified rate. A positive NPV indicates that the

investment is expected to generate more cash inflows than outflows and is considered financially viable.

- **Formula:**

NPV=Total present value of cash inflows - present value of cash outflows

Or

$$NPV - \sum_{t=0}^{N} \frac{CF_t}{(1+r)^t}$$

Where:

- CFt = Cash flow at time t (Initial investment at t=0 is negative)
- r = Discount Rate (Cost of Capital/WACC)
- N = Project Life

- **Decision Rule:**
  - If NPV≥0: Accept the project.
  - If NPV<0: Reject the project.
  - For mutually exclusive projects, choose the one with the highest positive NPV.
- **Advantages:** Considers time value of money, uses all cash flows, provides a direct measure of value added to the firm.
- **Disadvantages:** Requires a reliable discount rate, can be complex for manual calculation (but easy with software).
- **Modelling:** Create a table with years, cash flows, discount factors, and present values of cash flows. Sum the present values. Excel's NPV function (note: Excel's NPV function discounts future cash flows only, so you need to add the initial investment separately). Use PV function or manual calculation for each year.

- **4. Internal Rate of Return (IRR)**

- **Definition:** The discount rate that makes the Net Present Value (NPV) of a project equal to zero. It's the project's intrinsic rate of return.
- IRR is the discount rate at which the NPV of an investment becomes zero. It represents the rate of return generated by the investment and helps in comparing different investment opportunities. Projects with an IRR greater than the cost of capital are typically accepted.
- **Formula:**

- **IRR=% of Lower Rate+** $\frac{\text{NPV @ lower rate}}{\text{NPV @ lower rate-NPV @ Higher rate}} \times Diff.HR\ and\ LR$

Or

Where:

- CFt = Cash flow at time t (Initial investment at t=0 is negative)
- r = Discount Rate (Cost of Capital/WACC)
- N = Project Life

- Typically found by trial and error or using financial calculators/software (e.g., Excel's IRR function).
  - **Decision Rule:**
    - If IRR≥Cost of Capital: Accept the project.
    - If IRR<Cost of Capital: Reject the project.
  - **Advantages:** Considers time value of money, uses all cash flows, provides a rate of return which is intuitively appealing to managers.
  - **Disadvantages:** Can have multiple IRRs for non-conventional cash flows, assumes reinvestment of cash flows at IRR (which may be unrealistic), may conflict with NPV for mutually exclusive projects of different scales or lives.
  - **Modelling:** Use Excel's IRR function directly on the range of cash flows (including the initial negative outflow).

- **5. Modified Internal Rate of Return (MIRR)**

Modified Internal Rate of Return improves upon the IRR by assuming reinvestment of cash flows at the firm's cost of capital rather than the IRR itself. It provides a more realistic measure of profitability.

- The MIRR can be calculated using the formula:

$$\boldsymbol{MIRR = \left(\frac{FV(Positive\ cash\ flows)}{PV(Negative\ cash\ flows)} \right)^{\frac{1}{n}} - 1}$$

Where:

- FV(Positive Cash Flows) is the future value of positive cash flows compounded at the reinvestment rate.
- PV(Negative Cash Flows) is the present value of negative cash flows discounted at the finance rate.
- n is the number of periods.

3.2.1.4 Process involved in Capital Budgeting:

Below are seven essential processes, including Payback Period, Net Present Value (NPV), Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR):

1. Project Identification

The first step in capital budgeting involves identifying potential investment opportunities or projects that align with the company's strategic goals. This includes brainstorming ideas, conducting market research, and evaluating current business needs. It's crucial to gather a comprehensive list of projects to ensure that the selection process considers all viable options.

2. Cash Flow Estimation

Once potential projects are identified, the next step is to estimate the cash flows associated with each project. This involves forecasting the expected revenues, costs, and expenses over the project's lifespan. Accurate cash flow estimation is critical, as it serves as the basis for evaluating the project's financial viability through various methods like NPV and IRR.

3. Determining the Discount Rate

Choosing an appropriate discount rate is vital for the evaluation processes. The discount rate reflects the project's risk and the opportunity cost of capital. Typically, the Weighted Average Cost of Capital (WACC) is used, which accounts

for the cost of equity and debt financing. A well-calibrated discount rate ensures that future cash flows are appropriately valued.

4. Calculating Payback Period

The Payback Period measures the time required to recover the initial investment from the cash inflows generated by the project. This method is straightforward and helps assess liquidity risk. While it doesn't account for the time value of money, it provides a quick snapshot of how quickly the investment can be recouped, which is especially important for companies with tight cash flow constraints.

5. Calculating Net Present Value (NPV)

Net Present Value is a comprehensive method that involves discounting future cash flows back to their present value and subtracting the initial investment. A positive NPV indicates that the project is expected to generate value and is therefore a good investment. This method accounts for the time value of money, making it a robust measure of profitability and financial feasibility.

6. Calculating Internal Rate of Return (IRR)

Internal Rate of Return is the discount rate that makes the NPV of a project equal to zero. It represents the project's expected rate of return. IRR is particularly useful for comparing the profitability of different projects. If the IRR exceeds the company's required rate of return (often the WACC), the project is considered attractive. However, IRR can be misleading in projects with unconventional cash flows or multiple sign changes.

7. Calculating Modified Internal Rate of Return (MIRR)

MIRR addresses some limitations of IRR by assuming that positive cash flows are reinvested at the firm's cost of capital rather than at the IRR. This method provides a more accurate reflection of the project's profitability and reinvestment assumptions. It can help decision-makers compare projects more effectively and make informed investment choices.

3.2.1.5 Comparison of Methods:

- **NPV vs. IRR:** NPV is generally preferred for mutually exclusive projects as it maximizes shareholder wealth, especially when there are scale

differences or unusual cash flow patterns. IRR is often used as a secondary metric or for screening projects.

- **Discounting vs. Non-Discounting:** Discounting methods (NPV, IRR) are superior because they incorporate the time value of money and consider all relevant cash flows. Non-discounting methods are simpler but provide incomplete information.

3.2.1.6 Business Modelling in Excel for Capital Budgeting:

- **Structure:** Create a well-organized spreadsheet with clear sections for:
  - **Assumptions:** Initial investment, project life, sales volume, unit price, variable cost per unit, fixed costs, tax rate, salvage value, working capital requirements, discount rate (WACC).
  - **Revenue & Cost Projections:** Forecast annual revenues, variable costs, fixed costs.
  - **Depreciation Schedule:** Calculate annual depreciation (straight-line, WDV).
  - **Tax Calculation:** Calculate PBT, Tax, PAT.
  - **Cash Flow Statement for the Project:**
    - Net Income + Depreciation
    - Adjustments for Capital Expenditures (negative cash flow)
    - Adjustments for Working Capital changes (negative if increasing, positive if decreasing/recovered)
    - Terminal Cash Flow (salvage + recovered WC).
  - **Evaluation Metrics:** Calculate Payback Period, ARR, NPV, IRR.
  - **Sensitivity Analysis/Data Tables:** Crucial for exploring the impact of changes in key variables (e.g., sales volume, price, cost of capital) on NPV and IRR.
  - **Scenarios:** Best-case, worst-case, and most-likely scenarios.

3.2.17 Excel Functions for Corporate Financial Modelling - Tabular Summary

Topic	Key Concept/Goal	Relevant Excel Functions & Usage	Notes / Best Practices
1.1 Altman Z-Score	Calculating a composite score for bankruptcy prediction.	No direct function. Use basic arithmetic operators: +, -, *, /.	- Set up cells for each ratio (A, B, C, D, E) first. - Then, combine them in a single formula for the Z-Score (e.g., =1.2*A_Ratio + 1.4*B_Ratio + ...). - Ensure correct financial data inputs (e.g., Market Value of Equity for Ratio D).
1.2 Indifference Point Modelling	Finding EBIT where EPS of two financing plans are equal.	No direct function. Algebraic solution is then verified/solved in Excel. - Basic arithmetic (+, -, *, /) for EPS formulas. - Goal Seek (Data > What-If Analysis > Goal Seek) to find the EBIT.	- Set up two separate EPS calculations with a variable EBIT cell. - Goal Seek: Set (Cell for Plan A EPS - Cell for Plan B EPS) to 0 by changing the EBIT cell. - Crucial for capital structure decisions based on expected EBIT levels.
1.3 Financial Break-Even Modelling	Determining the sales volume/value	No direct function. Basic arithmetic operators based on	- Clearly define Fixed Costs, Variable Costs Per Unit, Selling Price Per

Topic	Key Concept/Goal	Relevant Excel Functions & Usage	Notes / Best Practices
	to cover costs and achieve target profit.	formulas. - SUM(), PRODUCT() or *, /.	Unit. - Calculate Contribution Margin Per Unit and Contribution Margin Ratio. - Use Data Tables (Data > What-If Analysis > Data Table) for sensitivity analysis on key inputs (e.g., price, variable cost).
2. Corporate Valuation & Capital Budgeting			
2.1 Corporate Valuation (Two-Stage Growth)	Valuing a company using multi-stage Free Cash Flow to Firm (FCFF).	Forecasting: - SUM() for aggregating line items. - PRODUCT() or * for applying growth rates. Discounting: - NPV(rate, value1, [value2], ...): For PV of cash flows. Remember to add Initial Investment separately if it's at time 0. - PV(rate, nper, pmt, [fv], [type]): For discounting individual components or Terminal Value. WACC Calculation:	- Organize: Assumptions, Forecasted FCFF (Year 1 to N), Terminal Value calculation, Discounting. - Named Ranges: Use for key inputs (e.g., WACC_Rate, Stable_Growth_Rate) to make formulas clear. - Sensitivity Analysis: Highly recommended to test assumptions using Data Tables or Scenario Manager.

Topic	Key Concept/Goal	Relevant Excel Functions & Usage	Notes / Best Practices
		- SUMPRODUCT() for weighted averages. - Basic arithmetic for the formula.	
2.2 Business Modelling for Capital Budgeting Evaluation	Evaluating investment projects using PBP, NPV, IRR, ARR.	Cash Flow Estimation: - SUM() for cash flow components. - PRODUCT() or * for tax/depreciation effects. Payback Period (PBP): - No direct function. Use logical IF() statements for automation or manual tracking of Cumulative Cash Flow. Accounting Rate of Return (ARR): - No direct function. AVERAGE() for average net income/investment. Net Present Value (NPV): - NPV(rate, value1, [value2], ...): Be careful with initial investment at time 0. -	

Topic	Key Concept/Goal	Relevant Excel Functions & Usage	Notes / Best Practices
		XNPV(rate, values, dates): Recommended for projects with unevenly spaced cash flows. Internal Rate of Return (IRR): - IRR(values, [guess]): For evenly spaced cash flows. - XIRR(values, dates, [guess]): Recommended for projects with unevenly spaced cash flows.	

UNIT 4

4.1 Portfolio Modelling: Risk Beta and Annualized Return

4.1.1 Portfolio Modelling – Introduction

Portfolio modelling refers to the process of constructing a combination of financial assets (stocks, bonds, etc.) that aims to maximize return and minimize risk based on investors' preferences and constraints.

4.1.2. Risk in Portfolio Management

Types of Risk:

- **Systematic Risk**: Market-wide risk (cannot be diversified)
- **Unsystematic Risk**: Firm-specific risk (can be reduced by diversification)

Total Risk = Systematic Risk + Unsystematic Risk

Measurement of Risk:

- **Variance (σ2\sigma^2σ2):** Measures the spread of data points from the mean.
- **Standard Deviation (σ\sigmaσ):** Square root of variance, used as a direct measure of portfolio risk.
- **Covariance (Cov(X,Y)Cov(X,Y)Cov(X,Y)):** Measures how two securities move together.
- **Correlation Coefficient (ρ\rhoρ):** Normalized covariance, ranging from -1 to +1.

4.1.3. Beta (β) – Systematic Risk Measure

Definition:

Beta measures the sensitivity of a stock’s return to the market return.

4.1.4. Risk Beta and Annualized Return:

Risk beta is a measure of a security's volatility in relation to the overall market. A beta of 1 indicates that the security's price moves with the market, while a beta

greater than 1 means higher volatility, and less than 1 indicates lower volatility. To calculate the annualized return of an investment, you need to take the total return (including price appreciation and dividends) over a specific period and annualize it using the formula:

Interpretation of Beta:

Beta Value	Interpretation
β = 1	Stock moves in line with the market
β > 1	Stock is more volatile than the market
β < 1	Stock is less volatile than the market
β = 0	No correlation with market
β < 0	Moves opposite to market

a. Formula for Beta:

$$\beta = \frac{\text{Cov}(R_i, R_m)}{\text{Var}(R_m)}$$

Where:

- Ri = Return of the stock
- Rm = Return of the market
- Cov = Covariance
- Var = Variance

b. Calculating Portfolio Beta

Formula:

$$\beta_p = \sum_{i=1}^{n} w_i \beta_i$$

Where:

- βp = Portfolio Beta
- wi = Weight of asset *i* in portfolio
- βi = Beta of asset *i*

4.1.5. Annualized Return

Definition:

Annualized return is the geometric average amount of money earned by an investment each year over a given time period.

a. Formula (for multi-period returns):

$$\text{Annualized Return} = \left(\prod_{t=1}^{n}(1 + R_t)\right)^{\frac{1}{n}} - 1$$

Where:

- Rt = Return in each period (monthly/quarterly)
- n = Number of periods per year

b. For Monthly Returns:

Annualized Return=(1+Monthly Return)12−1

Example:

If monthly return = 2% or 0.02

(1 + 0.02)^{12} - 1 = 1.2682 - 1 = 0.2682 = {26.82%}

4.1.6. Excel Implementation (Basics)

a. To Calculate Beta in Excel:

1. Get historical returns of stock and market index.
2. Use =COVARIANCE.P(stock_returns, market_returns)
3. Use =VAR.P(market_returns)
4. Then:
   Beta = COVARIANCE / VARIANCE

b. To Calculate Annualized Return:

If monthly returns are in range B2:B13:

Formula in excel:

=PRODUCT(1 + B2:B13)^(1/12) - 1

(Use Ctrl + Shift + Enter for array formula)

4.1.7. Process involved in calculation of RISK BETA AND ANNUALIZED RETURN:

1. Data Collection

The first step in developing a portfolio model is gathering relevant financial data for the assets under consideration. This includes historical price data, dividends, market returns, and risk-free rates. High-quality data is essential for accurate analysis, enabling the investor to make informed decisions regarding expected returns and risks associated with various securities.

2. Calculation of Returns

Once the data is collected, the next step is to calculate the historical returns for each security in the portfolio. This can be done using the formula:

$$Return = \frac{(P_t - P_{t-1} + D)}{P_{t-1}}$$

where P_t is the price at the end of the period, P_{t-1} is the price at the beginning of the period, and D represents any dividends received. This step provides a basis for estimating future performance and comparing different securities.

3. Estimation of Risk Beta

In this step, the risk beta of each security is calculated to understand its volatility relative to the market. This is typically done through regression analysis, where the returns of the security are regressed against the returns of the market index. The slope of the regression line represents the beta, indicating how much the security's returns are expected to move in relation to market movements. A beta greater than 1 indicates higher risk, while less than 1 suggests lower risk.

4. Annualizing Returns

To assess the performance of investments over time, annualized returns need to be calculated. This involves taking the total return over a specific period and converting it into an annual figure, allowing for better comparison among different investment options. The formula for annualized return has already been provided, and it gives a consistent basis for evaluating different assets on an annual basis.

5. Risk Assessment and Portfolio Diversification

Once individual betas and annualized returns are calculated, it's crucial to assess the overall risk of the portfolio. This involves evaluating how the securities' betas and correlations with each other impact the portfolio's total risk. Diversification strategies can be applied to minimize risk by combining securities with different risk profiles and low correlations, ensuring that the overall portfolio is not overly dependent on any single asset.

6. Optimization of Portfolio Weights

With the risk assessments completed, the next step is to optimize the weights of each asset in the portfolio. This can be done using techniques like Mean-Variance Optimization, which maximizes expected returns for a given level of risk or minimizes risk for a specified return. The optimal weightings should reflect the investor's risk tolerance and investment objectives, leading to a balanced portfolio that aligns with their financial goals.

7. Performance Evaluation and Rebalancing

The final step involves continuous monitoring and evaluating the portfolio's performance against set benchmarks. This includes reassessing the risk beta and annualized returns periodically to account for market changes. If the portfolio drifts away from its target risk-return profile due to market movements, rebalancing strategies may be employed to realign the asset weights, ensuring that the investment strategy remains effective over time.

7. Practical Uses in Portfolio Construction

- Use Beta to build portfolios based on risk tolerance.
- Use Annualized Return to evaluate long-term growth.

- Combine both to compare risk-adjusted performance.

4.2 SECURITY MARKET LINE MODELLING (SML Modelling)

4.2.1 What is the Security Market Line?

The Security Market Line represents the relationship between expected return and systematic risk (beta) as described by the Capital Asset Pricing Model (CAPM). The SML provides a benchmark for evaluating investment performance:

In short SML is

- The Security Market Line (SML) is a graphical representation of the Capital Asset Pricing Model (CAPM).
- It shows the expected return of an asset as a function of its systematic risk (Beta).
- The SML helps determine whether a security is fairly priced, overpriced, or underpriced.

4.2.2 Steps in Determining SML:

1. Defining the Risk-Free Rate

The first step is to establish the risk-free rate, which represents the return on an investment with no risk of financial loss. Typically, the yield on government securities, such as U.S. Treasury bonds, is used as the risk-free rate. This rate serves as the baseline for evaluating the expected returns of riskier assets and is crucial for calculating the SML.

2. Estimating the Expected Market Return

The next step is to determine the expected return of the overall market. This can be done using historical market returns, surveys of market participants, or a forward-looking approach based on economic indicators. The expected market

return reflects the average return that investors anticipate earning from the market as a whole, which is essential for establishing the SML's slope.

3. Calculating Beta for Each Security

Beta measures the sensitivity of an asset's returns to changes in the market return, quantifying its systematic risk. To calculate beta, historical price data for the security and the market index is analyzed, typically using regression analysis. This step is critical, as beta will determine a security's position relative to the SML, helping to assess its risk-return profile.

4. Constructing the SML Equation

With the risk-free rate, expected market return, and beta values in hand, the SML equation can be constructed using the Capital Asset Pricing Model (CAPM):

$$\boldsymbol{Expected\ Return = Rf\ +\ \beta(Rm - Rf)}$$

where R_f the risk-free rate, R_m is the expected market return, and β is the beta of the security. This equation serves as a framework to evaluate whether individual securities are fairly priced relative to their risk.

5. Plotting the SML

Once the SML equation is established, the next step is to graphically represent the SML on a scatter plot with beta on the x-axis and expected return on the y-axis. This visual representation allows for an easy comparison of individual securities' expected returns against the line. Securities above the SML are considered undervalued, while those below are overvalued.

6. Evaluating Individual Securities

Using the SML, investors can evaluate individual securities by comparing their expected returns to the returns indicated by their respective betas on the SML. This step involves identifying which securities offer excess returns (alpha) relative to their risk. By analyzing these discrepancies, investors can make informed decisions about which securities to include in their portfolios.

7. Portfolio Optimization Based on SML Analysis

Finally, the insights gained from the SML analysis can be utilized to optimize the overall portfolio. This involves selecting a mix of securities that align with the investor's risk tolerance and return objectives, ensuring that the portfolio is well-positioned on the SML. The goal is to achieve an efficient frontier where the portfolio's expected return is maximized for a given level of risk, enhancing overall investment performance.

4.2.3. The CAPM Equation (Core of SML)

$$R_i = R_f + \beta_i(R_m - R_f)$$

Where:

- RiR_iRi = Expected return of security
- RfR_fRf = Risk-free rate
- βi\beta_iβi = Beta of the security
- RmR_mRm = Expected return of the market
- Rm−RfR_m - R_fRm−Rf = Market Risk Premium

4.2.3.3. Security Market Line Graphically

- X-axis → Beta (β)
- Y-axis → Expected Return (R)
- Slope → Market Risk Premium (Rm−RfR_m - R_fRm−Rf)
- Intercept → Risk-free rate (RfR_fRf)

SML helps:

Use	Description
Determine fair return	Based on beta and market risk premium
Identify mispriced securities	Compare actual return vs. SML return
Evaluate portfolio performance	Compare expected return to required return

4.2.4. Interpreting the SML

Security Position	Interpretation
Above SML	Underpriced (higher return for risk)
On SML	Fairly priced
Below SML	Overpriced (lower return for risk)

4.2.5. Excel Modelling of SML

Columns to Set Up:

Security Beta (β) Required Return (CAPM) Actual Return Decision

Excel Formulas:

Assume:

- Risk-free rate: Cell B1 = 5%
- Market return: Cell B2 = 13%

In row for a security:

= B1 + B4 * (B2 - B1) → to compute CAPM required return

Then compare with actual return to decide:

- =IF(D4 > C4, "Underpriced", IF(D4 < C4, "Overpriced", "Fairly Priced"))

4.2.6. Applications of SML

Area	Use
Portfolio Management	Identify mispriced securities
Investment Valuation	Compute required return
Risk Analysis	Understand return-risk relationship

4.2.7. Limitations of SML

- Based on **CAPM assumptions** (which may not hold true)
- Requires accurate **estimation of Beta** and **Market Return**
- Does not account for **unsystematic risk**

4.2.8. Step-by-Step SML Calculation (Example)

Given:

- Risk-free rate RfR_fRf = 5%
- Market return RmR_mRm = 13%
- Beta βi\beta_iβi = 1.2

- **Using CAPM:**

Ri=5%+1.2(13%−5%)=5%+1.2(8%)=5%+9.6%=14.6%

The investor should expect **14.6% return** from this security

4.3 Portfolio Risk Calculation

4.3.1. Introduction to Portfolio Risk

- Portfolio risk refers to the total volatility of returns from a portfolio of assets.
- Risk is usually measured using standard deviation (σ) or variance (σ^2).
- The total risk of a portfolio depends on:
  - Individual asset risks (standard deviations)
  - The correlation between asset returns
  - The weights of each asset in the portfolio

4.3.2. Portfolio Risk – Two-Asset Case

- **Portfolio Variance Formula:**

$$\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2\rho_{12}$$

Where:

- w_1, w_2: Weights of Asset 1 and 2
- σ_1, σ_2: Standard deviations of Asset 1 and 2
- ρ_{12}: Correlation coefficient between Asset 1 and 2

3. Equal Proportions Case (Simple Portfolio Risk Calculation)

Assume:

- w1=w2=0.5 (equal weights)
- σ1=10%, σ2=15%
- ρ12=0.5

Portfolio Variance:

$\sigma p2=(0.5)^2(0.10)^2+(0.5)^2(0.15)^2+2(0.5)(0.5)(0.10)(0.15)(0.5)$
$=0.0025+0.005625+0.00375=0.011875$

Portfolio Standard Deviation:

$$\sigma_p = \sqrt{0.011875} = 10.90\%$$

Even though one asset is riskier, diversification lowers portfolio risk.

4.3. 4. Portfolio Risk with Varying Proportions (Optimization)

Assume:

- aw1=0.3, w2=0.7,
- σ1=10%, σ2=15%
- ρ12=0.5

a. Portfolio Variance:

$\sigma p2=(0.3)^2(0.10)^2+(0.7)^2(0.15)^2+2(0.3)(0.7)(0.10)(0.15)(0.5)$
$=0.0009+0.011025+0.00315=0.015075$

b. Portfolio Standard Deviation:

$\sigma p=0.015075=12.28\%$

4.3.5. Portfolio Risk Optimization

Portfolio optimization involves **choosing the best weights** of assets in a portfolio to:

- **Minimize risk** for a given level of return
- **Maximize return** for a given level of risk

This requires solving:

- Constraints: $\sum wi=1$, $wi\geq 0$

Objective: Minimize portfolio variance

Usually done using **Excel Solver** or **Python/R tools**.

4.3.6. Excel Implementation (2-Asset Portfolio)

Asset	Weight	σ (Std. Dev)	Return
Asset A	0.5	10%	12%
Asset B	0.5	15%	15%

Correlation = 0.5

In Excel:

- Portfolio Variance:

  =B2^2*C2^2 + B3^2*C3^2 + 2*B2*B3*C2*C3*0.5

- Portfolio Std Dev:
  =SQRT(<variance cell>)
- You can vary weights and plot the portfolio risk/return curve.

4.3.7. Efficient Frontier & Optimal Portfolio

- The efficient frontier is a set of optimal portfolios that offer:
  - The highest expected return for a given level of risk
  - The lowest risk for a given level of return
- An optimal portfolio lies on the efficient frontier and suits the investor's risk-return profile.

4.4 Portfolio Construction Modelling

4.4.1. What is Portfolio Construction?

Portfolio construction is the systematic process of selecting a mix of investments that align with an investor's:

- Return expectations
- Risk tolerance
- Investment horizon
- Constraints (liquidity, tax, ethics, etc.)

It is a core activity in portfolio management and forms the foundation for wealth creation, capital preservation, or risk hedging.

1.1 Stages in Portfolio Construction

Stage	Description
Investment Policy	Define risk tolerance, return objectives, and constraints
Asset Allocation	Decide on proportion of asset classes (equity, bonds, cash, etc.)
Security Selection	Choose individual securities within each asset class
Portfolio Optimization	Allocate weights to maximize return for a given risk or minimize risk for a given return
Performance Evaluation	Assess return, risk, Sharpe ratio, etc., and rebalance as needed

4.4.1.2 Asset Allocation

Types:

- Strategic (long-term target allocation)

- Tactical (short-term deviation from target to exploit opportunities)
- Dynamic (continuously adjusting to changing market conditions)

Example:

Asset Class	Allocation (%)
Equity	60%
Bonds	30%
Gold	5%
Cash	5%

4.4.2. What is Portfolio Construction Modelling?

Portfolio construction modelling is a systematic approach used by investors to build an investment portfolio that aligns with their financial goals, risk tolerance, and time horizon. It involves selecting a mix of assets (stocks, bonds, cash, etc.), determining their allocation, and ensuring diversification to optimize the risk-return profile. The key objective is to create a balanced portfolio that meets specific investment objectives while managing risk.

4.4.2.1 Steps involved in Portfolio Construction Modelling:

1. Define Investment Objectives

Before constructing a portfolio, it is important to clearly define the investment objectives. These objectives can vary from capital appreciation, income generation, or a balance of both. Factors such as risk tolerance, time horizon, liquidity needs, and specific financial goals (e.g., retirement savings, wealth accumulation) are considered during this phase. The investor's overall financial situation and life stage play a significant role in shaping these objectives.

2. Asset Allocation

Asset allocation is one of the most critical aspects of portfolio construction. It refers to how an investor divides their investments among different asset classes (e.g., equities, bonds, real estate, and cash). The key is to strike a balance between risk and return, as different asset classes behave differently in various market conditions. A well-diversified portfolio is designed to reduce unsystematic risk. Common asset allocation strategies include:

- **Strategic Asset Allocation:** Maintaining a fixed asset mix based on long-term goals.
- **Tactical Asset Allocation:** Adjusting the asset mix based on short-term market opportunities.
- **Dynamic Asset Allocation:** Continuously adjusting the asset allocation in response to changing market conditions or life circumstances.

3. Security Selection

Once asset allocation is determined, the next step is selecting specific securities within each asset class. This process involves:

- **Equity Selection:** Deciding on individual stocks or equity funds based on factors like company fundamentals, market trends, valuation metrics, and sectoral outlook.
- **Fixed-Income Selection:** Choosing bonds or debt instruments based on credit quality, interest rates, and duration to provide stability and income.
- **Alternative Assets:** Depending on risk tolerance, investors may include real estate, commodities, or hedge funds for diversification.

4. Risk Management

Portfolio risk management is about balancing the risk and return to ensure the portfolio is not overly exposed to volatility or potential losses. This involves:

- **Diversification:** Spreading investments across various asset classes, sectors, or geographic regions to minimize risk from any single asset.

- **Risk Assessment Metrics:** Using tools such as **beta**, **standard deviation**, and **Value-at-Risk (VaR)** to evaluate the portfolio's risk level. Ensuring that risk levels align with the investor's risk tolerance is crucial for long-term success.
- **Stress Testing and Scenario Analysis:** Running simulations to understand how the portfolio might perform under different economic conditions, such as recessions, inflation spikes, or interest rate hikes.

5. Optimization and Rebalancing

Optimization involves adjusting the portfolio to maximize expected returns for a given level of risk (or minimize risk for a given return). Modern portfolio theory (MPT) or more advanced methods like **mean-variance optimization** are often used to identify the most efficient asset allocation.

- **Rebalancing:** Over time, market movements can cause the portfolio's actual asset allocation to drift from its target allocation. Rebalancing brings the portfolio back to its intended asset mix by selling over-performing assets and buying under-performing ones. This can be done periodically (e.g., annually) or based on certain thresholds (e.g., when an asset class exceeds its target weight by a specified percentage).

6. Monitoring and Performance Evaluation

Ongoing monitoring is crucial to ensure that the portfolio continues to meet its objectives. This involves regularly reviewing the performance of individual assets and the portfolio as a whole against benchmarks. Performance metrics include:

- **Portfolio Return:** Calculating the actual return and comparing it to expected returns.
- **Risk-Adjusted Performance:** Using ratios like the Sharpe ratio and Treynor ratio to assess performance considering the portfolio's risk level.
- **Benchmark Comparison:** Evaluating how the portfolio has performed relative to a market index or relevant benchmarks for each asset class.

7. Adjusting for Changes in Investor Needs

As investors' goals, financial situations, or risk tolerances evolve, the portfolio may need to be adjusted. Life events, such as retirement, marriage, or changes in income, may require re-assessment of the asset allocation and overall portfolio strategy. Moreover, changing market conditions, interest rate environments, or economic shifts may also warrant portfolio adjustments to ensure it remains aligned with the investor's objectives.

4.4.3. Portfolio Construction Models

4.4.3.1 Markowitz Modern Portfolio Theory (MPT)

- Focus: Risk-Return Optimization
- Investors are risk-averse
- Portfolio risk = standard deviation of returns

Portfolio Variance Formula (Two Assets):

$$\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2\rho_{12}$$

Where ρ is the correlation coefficient

4.4.3.2 Capital Market Line (CML)

- Plots risk (σ) vs return for efficient portfolios (includes risk-free asset)
- Only efficient portfolios lie on the CML

4.4.3.3 Security Market Line (SML)

- Plots expected return vs Beta
- Used to evaluate individual securities, not portfolios

4.4.3.4 Efficient Frontier

- Set of optimal portfolios offering:
    - Highest return for given risk

- Lowest risk for given return

- Any portfolio below the frontier is inefficient

4.4.4. Portfolio Optimization Techniques

4.4.1 Minimum Variance Portfolio

- Portfolio with lowest possible risk
- Can be found using:
  - Excel Solver
  - Python/R libraries

4.4. 2 🔹 Mean-Variance Optimization

a. Maximize

$$\frac{E(R_p) - R_f}{\sigma_p}$$

b. Sharpe Ratio = (Expected Return – Risk-Free Rate) / Standard Deviation

Practical Example – Excel Modelling

Asset	Weight	Return	Std Dev	Beta
Stock A	0.4	12%	10%	1.2
Stock B	0.6	10%	8%	0.9

- Portfolio Return =

=SUMPRODUCT(weights, returns)

- Portfolio Risk (Std Dev) =

Use covariance matrix & variance formula

- Portfolio Beta =

=SUMPRODUCT(weights, betas)

4.5. Evaluation Metrics

Metric	Formula	Purpose
Sharpe Ratio	(Rp − Rf)/σp	Return per unit of risk
Alpha	Actual return − CAPM return	Performance over market expectation
Beta	Slope of regression of stock vs market	Systematic risk
R^2	Coefficient of determination	How well returns are explained by market

.

UNIT V

Derivative Modelling

5.1. Option Payoff Modelling

5.1.1: What is an Option?

- An option is a financial derivative that gives the buyer the *right*, but not the obligation, to buy or sell an underlying asset at a fixed price (called the strike price) on or before a given date (expiry).
- Two basic types:
    - Call Option → Right to buy
    - Put Option → Right to sell

5.1.2 What is a Payoff?

- Payoff is the profit or loss an investor realizes at expiry from holding an option position.
- It depends on:
    1. Spot price (S) at expiry
    2. Strike price (K) of the option
    3. Premium paid or received

Formula:

$$\text{Payoff} = \text{Intrinsic Value} - \text{Premium (if long)} + \text{Premium (if short)}$$

5.1.3 Why Do We Model Payoffs?

- To understand the risk–return profile of an option position.
- Helps traders, hedgers, and investors to:
    - Visualize potential gains and losses
    - Compare different strategies (e.g., protective put vs. covered call)

- Select strategies based on market view (bullish, bearish, neutral, volatile).

5.1.4. Types of Option Payoffs (Single-Leg Positions)

1. **Long Call (Buy Call Option)**
   - Right to buy at strike price.
   - Limited loss (premium), unlimited profit if price rises.
   - **Payoff formula**:
     Payoff=max(S_T−K,0)−C_0
     Where:
     S_T = Stock price at expiry,
     K = Strike price,
     C_0= call premium.

- **Interpretation**: Unlimited upside, maximum loss = premium.
- **Excel setup**:
  - Column A: Spot Price Range (e.g., 50 to 150)
  - Column B: Payoff = =MAX(A2 - K,0) - Premium
  - Plot line chart.

2. **Short Call (Sell Call Option)**
   - Obligation to sell at strike price.
   - Limited profit (premium), unlimited potential loss.
   - **Payoff formula**:

     Payoff=C_0−max (S_T−K,0)
   - **Interpretation**: Limited gain = premium, unlimited loss if stock price rises.

3. **Long Put (Buy Put Option)**

- Right to sell at strike price.
- Limited loss (premium), large profit if price falls.
- **Payoff formula**:
  - Payoff=max(K−S_T,0)−P_0
- **Interpretation**: Limited downside protection, maximum loss = premium.

4. **Short Put (Sell Put Option)**
   - Obligation to buy at strike price.
   - Limited profit (premium), large loss if price crashes
   - **Payoff formula**:
     Payoff=P_0−max (K−S_T,0)

- **Interpretation**: Limited profit (premium), large downside if stock falls.

5.1.5 Payoff Diagrams

- A **payoff diagram** is a graphical representation of profit/loss at expiry.
- **X-axis** → Spot price at expiry (S)
- **Y-axis** → Profit/Loss (Payoff)
- Shapes:
  - Long Call = upward hockey stick
  - Long Put = downward hockey stick
  - Short Call = inverted long call
  - Short Put = inverted long put

5.1.6. Building Payoff Tables

- To model payoffs, we prepare a table of spot prices at expiry and calculate payoffs.

Excel Payoff Table Example

Spot Price	Long Call	Short Call	Long Put	Short Put
80	0-5=-5	+5-0=+5	20-5=15	5-20=-15
100	0-5=-5	+5-0=+5	0-5=-5	5-0=+5
120	20-5=15	5-20=-15	0-5=-5	5-0=+5

So Option Payoff Modelling = Quantifying and visualizing the profit/loss outcome of different option positions under different market scenarios**.**

5.2. Black–Scholes Option Pricing Model (B–S Model)

5.2.1. Introduction

- The Black–Scholes Model (1973), developed by Fischer Black, Myron Scholes, and Robert Merton, is the most widely used mathematical model for option pricing.
- It provides a theoretical fair value of a European call or put option on a non-dividend-paying stock.
- The model revolutionized financial markets, earning the authors a Nobel Prize (1997).

5.2.2. Concept of Option Pricing

- Options derive their value from two components:

1. Intrinsic Value → Value if exercised today (e.g., for a call = max(S – K, 0)).
2. Time Value → Extra premium traders pay for the possibility of favourable movements before expiry.

- The Black–Scholes formula captures both of these by using probability distributions of stock price movements.

5.2.3. Key Assumptions of B–S Model

1. The option is European (can be exercised only at maturity).
2. No dividends during the option's life.
3. Markets are efficient (no transaction costs, no taxes).
4. Risk-free interest rate (r) and volatility (σ) are constant.
5. Stock prices follow a lognormal distribution (continuous compounding, random walk).
6. Continuous trading possible.

5.2.4 Formula:

European Call Option

$$C = S_0 N(d_1) - Ke^{-rT} N(d_2)$$

European Put Option

$$P = Ke^{-rT} N(d_2) - S_0 N(d_1)$$

Where:

$$d_1 = \frac{\ln(S_0/K) + (r + \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}, \quad d_2 = d_1 - \sigma\sqrt{T}$$

📌 **Symbols**

- S_0: Current stock price
- K: Strike price
- T: Time to maturity (in years)
- r: Risk-free interest rate
- σ: Volatility of stock returns
- $N(d)$: Standard normal cumulative distribution

5.2.5 Why only European in B–S?

- Because the model assumes continuous trading and no early exercise.
- American options (which can be exercised anytime before maturity) need different approaches like:
    - Binomial Model (Cox–Ross–Rubinstein)
    - Finite Difference Methods
    - Monte Carlo Simulations

However, for non-dividend paying stocks, the value of an American call = European call (since early exercise gives no advantage).

5.2.6 Why does it work?

- $N(d_1)$: Probability (in risk-neutral world) that option finishes *in the money*.
- $N(d_{2)})$: Probability (adjusted for discounting) that strike will be paid.
- $S_0N(d_1)$: Expected benefit from holding the stock.
- $Ke^{-rT}N(d_2)$: Present value of expected payment at expiry.

So, **Option = Benefit – Cost**.

Example

Suppose:

- Current Stock Price S_0=100
- Strike Price K=105
- Time to Expiry T=1 year
- Risk-free Rate r=5%(0.05)
- Volatility σ=20%(0.20)

Step 1: Compute d_1, d_2

$$d_1 = \frac{\ln(100/105) + (0.05 + 0.5 \times 0.2^2) \times 1}{0.2 \times \sqrt{1}}$$

$$= \frac{-0.0488 + 0.07}{0.2} = \frac{0.0212}{0.2} = 0.106$$

$$d_2 = d_1 - 0.2 = 0.106 - 0.2 = -0.094$$

Step 2: Find Normal CDF values

- $N(d_1 = 0.106) \approx 0.542$
- $N(d_2 = -0.094) \approx 0.463$

Step 3: Apply Call Formula

$$C = 100 \times 0.542 - 105 \times e^{-0.05} \times 0.463$$

$$= 54.2 - 105 \times 0.9512 \times 0.463$$

$$= 54.2 - 46.3 = 7.9$$

Fair value of Call = 7.9

Step 4: Use Put-Call Parity to check

$P=C+Ke^{-rT}-S_0$

$P=7.9+99.88-100=7.78$

Fair Value of Put = 7.78

5.2.7. Extensions of B–S

- Dividend-paying assets → Modified B–S formula includes a continuous dividend yield qqq.
- Currency Options → Garman–Kohlhagen Model.
- Futures Options → Black's Model (1976).

5.2.8 Sensitivity to Inputs / Interpretations:

- Higher Volatility (σ) → Increases both Call & Put value.
- Higher Time to Maturity (T) → Increases option value.
- Higher Risk-free Rate (r) → Call goes up, Put goes down.
- Higher Stock Price (S_0) → Call goes up, Put goes down.

5.2.9 Greeks

- **Delta**: Sensitivity to stock price.
- **Gamma**: Change in Delta per unit move.
- **Vega**: Sensitivity to volatility.
- **Theta**: Sensitivity to time decay.
- **Rho**: Sensitivity to interest rate.

5.2.10 Applications

- Valuation of European options (calls & puts).
- Basis for real options analysis (capital budgeting under uncertainty).
- Foundation for exotic option pricing and risk management models.
- Used in hedging & risk-neutral valuation frameworks.

5.2.11. Limitations

- Assumes constant volatility & interest rates.
- No transaction costs or taxes → unrealistic.
- Only works for European options (not early exercise).
- In practice, markets often show **"volatility smile"** (implying volatility is not constant).

5.2.12 Excel Implementation

- Input: Spot (S0), Strike (K), Volatility (σ), Time (T), Risk-free rate (r)

- Calculate d1 and d2 using LN, SQRT, EXP, NORMSDIST functions.
- Call price = =S0*NORMSDIST(d1) - K*EXP(-r*T)*NORMSDIST(d2)
- Put price via Put–Call parity.

5.3. Option Hedge Contract Modelling

5.3.1. Introduction to Option Hedging

In financial markets, investors and businesses constantly face uncertainty. Prices of shares, commodities, currencies, and interest rates can move in either direction, creating both opportunities and risks. While profit-making investors may speculate, risk-averse investors and businesses focus on hedging.

- Hedging means taking a position to offset potential losses in an investment or business activity.
- Options are extremely useful for hedging because they give flexibility: the buyer of an option has the *right but not the obligation* to buy (Call) or sell (Put) an asset at a pre-agreed strike price.

This feature makes options ideal for designing insurance-like contracts, where downside risks are limited, but upside potential may be partly or fully retained.

5.3.2. Basic Option Concepts Refresher

Before building hedge contracts, students should recall:

- Call Option: Right to buy at strike price.
- Put Option: Right to sell at strike price.
- Premium: The upfront price paid for the option.
- Exercise / Expiry: The date when option rights can be used.
- Payoff Function: Value at expiry (intrinsic value).
- Profit/Loss Function: Payoff – Premium.

Mathematical Form:

- Call Buyer: $\max(S - K, 0) - C$
- Put Buyer: $\max(K - S, 0) - P$

Where:

- S = Stock price at expiry
- K = Strike price
- C, P = Premiums of call and put

5.3.3. Why Hedge with Options?

- To protect downside risk (like an insurance policy).
- To stabilize cash flows (useful for businesses like airlines or exporters).
- To design flexible contracts (choose strike, maturity, premium trade-off).
- To benefit from volatility (if prices move a lot).

Example in Real Life:

- An Indian exporter earning in USD may buy a Put on USD-INR to hedge against INR appreciation.
- An airline may buy oil options to hedge against rising fuel prices.

5.3.4. Major Option Hedge Strategies

Now we build structured contracts combining stocks and options.

5.3.4.1 Protective Put (Insurance Strategy)

- Position: Buy Asset + Buy Put.
- Purpose: Provides a *floor* to losses, but retains upside gains.

- Analogy: Like buying insurance for your car – you pay a small premium, but your loss is capped.

Payoff Equation:

Payoff Equation:

$$\text{Protective Put P/L} = (S - S_0) + \max(K - S, 0) - P$$

Where S_0 = initial stock price.

Example:

- Buy stock at ₹100.
- Buy Put, Strike ₹95, Premium ₹3.

Stock Price at Expiry	Stock P/L	Put Payoff	Net P/L
70	-30	+25	-5
90	-10	+5	-5
100	0	0	-3
120	+20	0	+17

Interpretation: The investor cannot lose more than ₹5 (insurance premium + minor difference), but enjoys most of the upside.

5.3.4.2 Covered Call (Income Strategy)

- Position: Buy Asset + Sell Call.
- Purpose: Generate extra income from premiums when expecting limited upside.
- Limitation: Caps profits beyond strike price.

Payoff Equation:

$$\text{Covered Call P/L} = (S - S_0) - \max(S - K, 0) + C$$

Example:

- Buy stock at ₹100.
- Sell Call, Strike ₹110, Premium ₹5.

Stock Price at Expiry	Stock P/L	Call Payoff	Net P/L
90	-10	0	-5
100	0	0	+5
110	+10	0	+15
120	+20	-10	+15

Interpretation: Income is enhanced up to ₹15 maximum. Beyond that, upside is capped.

5.3.4.3 Collar (Range-Bound Hedge)

- Position: Buy Asset + Buy Put (downside insurance) + Sell Call (to fund insurance).
- Purpose: Locks the stock in a range.
- Cost: Often structured to be *zero-cost* (Put premium = Call premium).

Example:

- Buy stock at ₹100.
- Buy Put (K=95, P=3).
- Sell Call (K=110, C=3).

Stock Price	Stock P/L	Put Payoff	Call Payoff	Net P/L
80	-20	+15	0	-5
95	-5	0	0	-5
110	+10	0	0	+10
120	+20	0	-10	+10

Interpretation: The investor cannot lose more than ₹5, but also cannot gain more than ₹10. Risk and return are both limited.

5.3.4.4 Straddle (Volatility Hedge)

- Position: Buy Call + Buy Put (same strike).
- Purpose: Beneficial when expecting a *big move* in either direction.
- Risk: High premium cost if market stays stable.

Example:

- Call Premium = ₹5, Put Premium = ₹5. Strike = ₹100.

Stock Price	Call P/L	Put P/L	Net P/L
80	0	+15	+5
100	-5	-5	-10
120	+15	0	+5

Interpretation: Loss if price stays near strike. Profit if price jumps up or down.

3.4.5 Strangle (Cheaper Volatility Hedge)

- Position: Buy OTM Call + Buy OTM Put.
- Cheaper than straddle, but needs bigger move to be profitable.

5.3.5. Advanced Hedging – Delta Hedging

Options' sensitivity to underlying prices can be measured using Greeks.

- Delta (Δ): Change in option price per unit change in stock price.
- To hedge a stock portfolio, one can calculate:

$$\text{Hedge Ratio (h)} = \frac{\text{Value of Portfolio}}{\text{Contract Size} \times \Delta}$$

Example:

- Portfolio = ₹10,00,000.
- Option Delta = 0.5, Contract size = 100.
- Hedge ratio = 200 contracts needed.

5.3.6. Advantages and Disadvantages of Option Hedging

Advantages:

- Limited risk exposure.
- Flexibility in strategy.
- Can create cost-effective hedges.
- Helps in volatility management.

Disadvantages:

- Premium costs may be high.
- Requires understanding of Greeks.
- May limit upside gains.
- Complexity in structuring collars and spreads.